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MASONRY

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MASONRY

A Handbook of Tools, Materials, Methods, and Directions

BY

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CONTENTS

INTRODUCTION

This book concerns the common methods of constructing and surfacing walls and other structural elements, using such materials as concrete, plaster, stucco, bricks, and concrete and glass blocks. The chapter or chapters which deal with each of these materials are completely self contained units, covering the materials, tools, operations, and processes.

Chapter 1 is a discussion from the standpoint of the home owner, of concrete work. Detailed information is given about materials to use in making concrete, the proportions, and the details of pouring the concrete and finishing its surface. Four specific projects show the application of these methods to improvements to be made around the home.

Chapter 2 explains the plastering operations that are followed in finishing interior walls. Particular attention is paid to the methods of installing the various plaster bases of wood, metal, or manufactured materials, which are necessary to hold the plaster coating.

Chapter 3 deals with the application of stucco to the outside of the house. The directions are sufficiently detailed to enable the home owner to understand the methods to be followed in obtaining an attractive and durable finish.

Chapters 4, 5, and 6 deal with bricklaying. Chapter 4 describes the common types of brick, the various proportions in which mortar is mixed, and the tools used in applying mortar, and in constructing brickwork. Chapter 5 describes in considerable detail the methods of brick construction. It shows the various operations and tricks of the trade that are necessary in order to lay brick properly. The types of joints between bricks and the various arrangements of brick in ordinary wall construction (common bond, English bond, Flemish bond, etc.) are described and illustrated. Chapter 6 is a glossary of bricklaying terms, which will be found convenient for reference when reading the chapters on brickwork, although as far as possible each new term is described when it is first used.

Chapter 7 deals with masonry construction with some materials other than brick, notably concrete blocks. The methods of bonding of these materials into brick walls are also described.

Chapter 8 describes and illustrates glass block construction.

Chapter 1

CONCRETE

Concrete: Portland Cement, Fine Aggregate, Coarse Aggregate, Water, Water-Cement Ratio . . . Estimating Quantities . . . Mixing Concrete: Measuring Box, Hand Mixing, Machine Mixing . . . Placing Concrete . . . Protection of Concrete . . . Watertight Concrete . . . Waterproofing Compounds . . . Membrane Waterproofing . . . Concrete Work in Cold Weather . . . Surface Finishes . . . Stripping Forms . . . Concrete Projects: Stoop and Steps, Flagstone Walk, Shuffle Board, Sidewalk

Concrete is a carefully proportioned mixture of cement, fine aggregate (sand), coarse aggregate (crushed stone, gravel, steam cinders, etc.), and clean water. The cement serves to bind the fine and coarse aggregates into a dense mass. In its semiliquid state, concrete may be cast, molded, or sprayed under pneumatic pressure into practically any shape or size desired. The change from a soft, watery mixture to a solid mass is known as *setting*. After the first *set* concrete hardens slowly until it resembles natural stone.

Portland Cement. The word *Portland* refers to a type of cement and not to the name of a brand. The first manufactured cement was made in about 1825. It resembled the color of the gray limestone quarried on the Isle of Portland, England, and was named accordingly. Today the term Portland cement designates the common, gray cement that is used throughout the world to make concrete or mortar. There are many brands of Portland cement sold in the United States, but the manufacturing process is essentially the same for all. Cement is packed, ready for use, in paper bags that hold approximately 1 cu. ft. and weigh 94 lbs. per bag when filled at the factory.

Fine Aggregate. Sand is fine *aggregate.* Sand particles vary in size from very fine to those which will just pass through a screen with a ¼″ mesh. Sand to be used in concrete should be clean and sharp, without any admixture of clay, loam, weeds, or fine dust. These foreign materials prevent good bond between the cement and sand, with a resulting loss of strength. Bank run sand is a natural mixture of sand and gravel which may be used after screening out all pebbles and foreign materials. River bank sand that contains mud or slime should not be used, because its greasy nature prevents

proper bonding with cement. Seashore sand is also unsatisfactory, because it contains substances that cause disintegration of the concrete

Cleaning Sand. Sand may look clean and yet contain fine dust or dirt. A simple test will show the condition of sand. Obtain a 12 oz. bottle and place in it 4″ of the sand to be tested. From a drugstore obtain a pint of 3% caustic soda solution (sodium hydroxide solution) and pour it into the

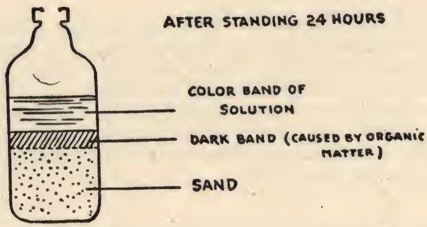


FIG. 5.1. This sketch shows the appearance of the test for clean sand after standing 24 hours.

bottle of sand until it stands about 3″ over the sand. Shake thoroughly, and allow the bottle and contents to stand undisturbed for 24 hours. The color of the liquid after standing is a good indication of the cleanliness of the sand. The contents of the bottle separate into 3 distinct bands as shown in Fig. 5.1. If the liquid top band is colorless or only a light yellow in color, the sand may be considered clean, in so far as organic impurities are concerned. A band of dark colored liquid just above the sand indicates the presence of organic impurities, and the sand should not be used unless these impurities are washed out.

Sand may be washed free of most impurities by means of a simple inclined trough with cleats nailed across the bottom to make ripples, as shown in Fig. 5.2. The trough has a fine ⅛″ mesh screen at the bottom through which the sand and water drain. The sand is shoveled in at the top and washed down with a hose. Dirty water will drain away from the sand pile under the trough, leaving the sand clean and ready for use.

Wet sand occupies more space than dry sand and is more difficult to handle with the ordinary hand tools. The excess water also causes difficulty in proportioning the sand correctly when mixing concrete or mortar. For these reasons, sand should be permitted to drain as dry as possible before it is used.

Coarse Aggregate. Crushed stone, pebbles, steam cinders, etc., are *coarse*

aggregate. Since the strength of concrete is limited by the strength of the aggregate, all this material should be clean, hard, and free from organic matter, such as sewage, manure, or loam. The size of the coarse aggregate depends upon the type of work. For thin walls or construction where the concrete must be worked around reinforcing steel, the aggregate should be graded up to 1″ size. Large mass concrete may use sizes graded up to, and

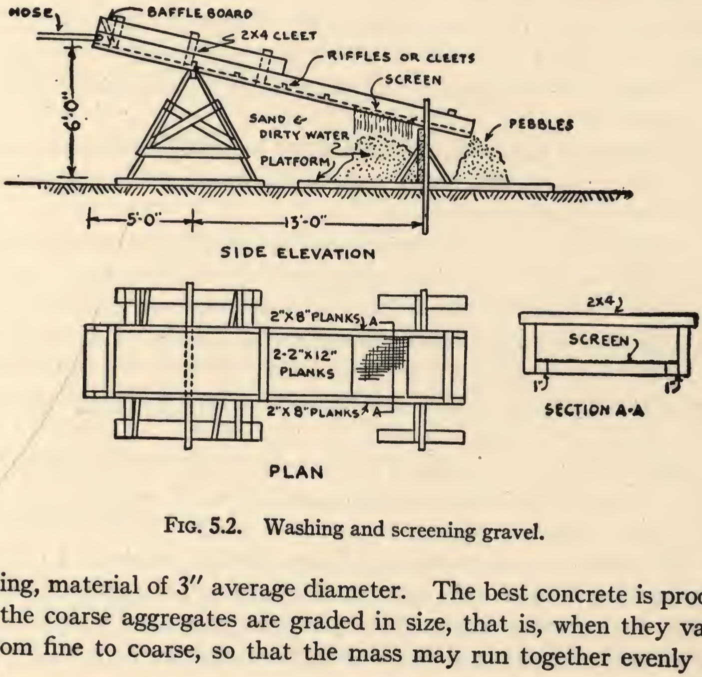


FIG. 5.2. Washing and screening gravel.

including, material of 3″ average diameter. The best concrete is produced when the coarse aggregates are graded in size, that is, when they vary in size from fine to coarse, so that the mass may run together evenly when mixed.

Gravel is a mixture of sand and pebbles just as it is taken from the bank or pit without screening. It is not suitable for concrete because the percentage of sand that it contains is not known and so the correct proportion can not be figured. Therefore, the sand and pebbles in gravel should be separated by washing and screening as shown in Fig. 5.2, after which they may be combined in the correct proportions.

Water. Clean water is as important as clean aggregates in making concrete. It must be free from dirt, acid, alkali, oil, or vegetable matter. Sea water should never be used, because of its salts. In general, only water that is fit to drink will make good concrete.

Water-Cement Ratio. Until recent years it was customary to ignore the *water-cement ratio,* and merely to specify concrete mixtures as one part cement to a certain number of parts of sand and coarse aggregate. Modern practice is to state the exact amount of mixing water for each bag of cement, according to the type of work. It has been found that close attention to the water-cement ratio, as it is called, will more than repay the little extra effort involved in measuring the water accurately. The underlying principle of this method may be stated as follows: For plastic mixes using sound aggregates, the strength and other desirable properties of concrete, under given job conditions, are governed by the *net* quantity of mixing water used per sack of cement.

Water carried by damp or wet sand must be considered as part of the water in the water-cement ratio, and an allowance made for this extra moisture as each batch is mixed.

No one formula for mixing concrete can be expected to meet the entire range of conditions of stress, wear, watertightness, and economy. Research and practical experience under actual job conditions have evolved concrete mixes suitable for several general types of work. Table 1 gives the recommended quantities of water for different classes of work as well as the proportions of cement to sand and coarse aggregate that have proved successful for each type of construction.

The *proportion* of other material to concrete is usually given by volume. Cement is measured by the bag, which contains 1 cu. ft., and the aggregates in cubic feet. Water is measured by the U. S. gallon. It is standard practice to designate a concrete mix by three numbers, such as 1 : 3.75 : 5. The first number always refers to the number of bags of cement; the second number is the number of cubic feet of fine aggregate, usually sand and the third number is the number of cubic feet of coarse aggregate, such as pebbles, crushed stone, steam cinders, etc.

A trial batch should be mixed and tested for workability before the final proportions of a particular mix are fixed. It may be found that the exact proportion of water given in Table 1 results in a mixture that is too stiff, too wet, or lacking in smoothness and workability. This situation may be remedied easily by changing the amount of the aggregates slightly, but *not the water.* If the mix is too wet, add sand and pebbles slowly until the desired stiffness is obtained. If the mix is too stiff, cut down the proportion of the sand and coarse aggregate *slightly* in another trial batch.

Estimating Quantities. Table 1 may be used for estimating the quantities of cement and aggregates needed for a job, and hence the cost of mate-

Table 1

Kind of Concrete Work	Mix by Vol. Materials Cubic Feet			Workability of the Mix	Gals. Water per Bag When Mixing	One Bag Batch Makes This Much Concrete — Cu. Ft.	Materials for One Cubic Yard of Concrete			
	Cement Bags	Sand Cu. Ft.	Stone Gravel Cu. Ft.				Cement Bags	Sand Cu. Ft.	Stone Gravel Cu. Ft.	Gals. Water When Mixing
Footings, Heavy Foundations	1	3.75	5	Stiff	6.4	6.2	4.3	16.3	21.7	27.6
Watertight Construction, Walls	1	2.5	3.5	Med.	5	4.5	6.0	15.0	21.0	30
Driveways, Floors, Walks — One Course	1	2.5	3	Stiff	4.4	4.1	6.5	16.3	19.5	28.7
Driveways, Floors, Walks — Two Courses	1	Top 2	0	Stiff	3.6	2.14	12.6	25.2	0	45.3
	1	Bottom 2.5	4	Stiff	4.9	4.8	5.7	14.2	22.8	27.8
Pavements	1	2.2	3.5	Stiff	4.3	4.2	6.4	14.1	22.4	27.5
Watertight Construction for Tanks, Wells, Cast units like posts, slabs	1	2	3	Med.	4.1	3.8	7.1	14.2	21.3	29.3
				Wet	4.9	3.9	6.9	13.8	20.7	33.7
Heavy Duty Floor, Barns, Shops, etc.	1	1.25	2	Stiff	3.4	2.8	9.8	12.3	19.6	33.9
Mortar for Brick, Concrete Blocks	1	6	1 Sack 50 lb. Hydrated Lime	Med.	12.5	5.5	4.9	29.4	5	61.2

rials, based on local prices. For example, a footing 27′ long, 2′ wide, and 1′ thick requires 54 cu. ft. or 2 cu. yds. of concrete. A 1 : 3.75 : 5 mix is recommended for this type of work by Table 1. To make 1 cu. yd. of this mix it is necessary to use 4.3 bags of cement, 16.3 cu. ft. of sharp sand, and 21.7 cu. ft. of gravel or crushed stone, and 27.6 gal. of clean water. Although the total volume of the materials when dry is much greater than 1 cu. yd. the addition of water reduces the net volume by causing the sand and cement to fill in the voids in the coarse aggregate. To obtain the 2 cu. yds. of concrete required for the footing it is necessary to double the quanti-

ties just given for one cubic yard. No allowance for waste is included in Table 1 and this factor cannot be ignored. It is customary to allow about 5% to 10% for material waste, on the job, so the following quantities should be purchased for the footing: cement, 9 bags; sand, 1⅓ cu. yds; gravel or crushed stone, 1¾ cu. yds.

Mixing concrete or mortar involves several simple operations and requires some forethought. Excellent concrete can be mixed by hand, although machine mixing is preferred because better quality concrete results. All materials should be piled near the mixer or mixing platform, the cement on planks or a platform with some cover, such as a rough shed or tarpaulin over

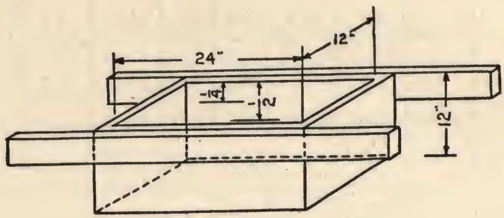


FIG. 5.3. Measuring box.

A measuring box is one of the handiest tools for getting the exact proportions of sand or gravel that a particular mix requires. The sketch shows a bottomless box that may be filled with the aggregates, one at a time, and then lifted to empty. Marks on the inside of the box may be placed to indicate fractional parts of a cubic foot.

the bags to protect them from dampness. Sand and the coarse aggregate should be ready in *separate* piles near the mixing point, in sufficient quantities to permit the concrete work to continue without stoppage until convenient.

All materials, including water, must be measured accurately for each batch. A pail marked inside at different heights, to indicate gallons and quarts, is handy for measuring the quantity of water as computed from Table 1. A pail may be used also to measure cement, sand, and coarse aggregate if necessary.

Measuring Box. A simple and convenient measure for proportioning aggregates is a bottomless measuring box, shown in Fig. 5.3. This measure is simply a strong box with no bottom, made to exact *inside* measurements. The handles help in lifting or moving the box. As shown it has a capacity of 2 cu. ft., with marks on the inside of the box for 1 cu. ft. and for ½ cu. ft.

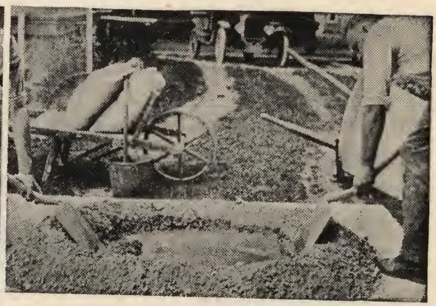
If a tight, level space is not available for mixing concrete by hand, a mix-

ing platform should be made. It may be made of smooth planks, but matched tongue and groove boards, nailed to cleats, make a watertight floor that is preferable, with strips nailed along the sides to keep the materials from falling off the floor while being mixed. Square end shovels, a hoe, and a wheelbarrow complete the tools needed for hand mixing.

Step *A*.

Step *B*.

Step *C*.



Step *D*.

Fig. 5.4. View of mixing concrete by hand. *Courtesy Portland Cement Assn.*

Hand Mixing of Concrete. Usually a one bag batch is the most convenient amount of concrete to mix by hand. The aggregates are thus proportioned in cubic feet according to the particular mix selected for the work. in Fig. 5.4, steps *A*, *B*, *C*, and *D* show the correct way to measure and mix dry cement, sand, and coarse aggregate until ready for the water. Place the measuring box in the middle of the mixing floor, and continue to fill and empty it until the correct amount of sand is spread evenly in a ring on the floor. Carry a bag of cement to the sand ring, place it on the sand, and cut

it open along one side. In this way, the bag may be emptied without effort, or loss of cement. The sand and cement should be turned over with the shovels, until the color of the batch is a uniform gray, with no streaks of brown and light gray. The required quantity of coarse aggregate is next added, by setting the measuring box on the ring of sand and cement, and continuing to fill and empty it, until the correct amount of the material has been placed on the pile. Figure 5.4, step *B*, shows the measuring box full of coarse aggregate ready to add to the pile. Once again the pile is turned over thoroughly (Step *C*) until the coarse aggregate is spread evenly, with no streaks of color. The dry mix is now spread in a ring as shown in Fig. 5.4, step *D*, and a measured quantity of clean water is poured into the hollow. The dry materials are now hoed or shoveled into the puddle of water, without splashing or allowing any of the water to break through and run off. This shoveling and mixing must be continued until the cement, sand, and coarse aggregate have been combined to form a uniform color and consistency, without puddles or dry spots. Tests show that the strength of concrete is increased by taking time to mix the agrgegates. It should take at least 5 minutes of rapid shoveling to complete a well mixed batch of concrete.

Machine Mixing. Mixing concrete by hand is a slow and laborious job. A small portable concrete mixer will do a better job at a great saving of time and energy. Mixers, both hand and gas engine operated, may be rented or purchased. The cost of this equipment is small compared with the saving in time and labor that may be effected by its use. A half-bag machine is probably most efficient for jobs which require only one or two workmen. The aggregates and cement are measured carefully and poured into the drum of the machine as it is revolving. The correct amount of water is then added and the mix allowed to tumble and blend in the drum for 2 or 3 minutes.

Placing Concrete. Wet concrete should be placed within 30 minutes of mixing. This prevents water from separating, and also prevents an initial set from taking place before the concrete is in position. It is just as important to prevent separation of the aggregates in the forms, as it is to prevent their separation when mixing or transporting the concrete from the mixer. It is good practice to deposit concrete directly into the forms, rather than to place it in heaps, and then drag or shovel it where needed. Concrete deposited uniformly in the forms in 6″ layers will not segregate and honeycomb.

Thoroughly mixed concrete delivered at the proper consistency and mois-

ture-content may be placed easily but further care is necessary to be sure that all angles or small spaces are filled properly with the material. A small rod or a piece of 2 × 4 may be used to ram or work the concrete around and into small out-of-the way spaces. This action also helps to eliminate air pockets along the sides of the form itself. Another way of preventing voids or air pockets is to vibrate the forms after they have been filled. On large jobs small machine driven vibrators are fastened to the forms and shifted from time to time after the concrete appears to have settled as far as possible. On small work the forms may be tapped firmly with a heavy hammer as the forms are filled, to drive out the small air bubbles and fill the voids solidly.

At the end of a day's run, or where the work must be stopped long enough for the concrete to set, the top surface is roughened with a stiff broom or brush just before it hardens. This removes the scum as it forms and provides a good bonding surface for the next layer of concrete. Just before the next concrete is poured, the roughened surface is cleaned, and then brushed with a thick cement water paste of creamy consistency. This paste is applied in a thick brush coat, just a few feet ahead of the new concrete, so that it does not have a chance to dry before the new concrete covers it.

Unless care is used in providing a bond between different layers of concrete, seams will form between layers and invite leaks. The need for making a good bond between layers of concrete is very important wherever concrete construction is to be watertight.

Protection of Concrete. Concrete must be protected against quick drying because too rapid drying is likely to cause cracks, and a structural weakness not readily apparent. If the forms are not removed for several days after the concrete is poured, they will provide sufficient protection. If they must be removed as soon as the concrete is set but still green, the exposed surfaces should be covered completely with canvas, burlap, or straw. The covering material should be kept damp for several days to prevent the concrete from drying out too rapidly. The presence of sufficient moisture in the concrete mass, during the early hardening period of 10 days to 2 weeks, produces greater strength and freedom from surface cracks than can be obtained in concrete not so protected.

Large flat areas such as floors, sidewalks, driveways, walls, and watertight tanks require special protection to ensure slow and even drying. This is sometimes called *curing*, and simply means that the concrete is kept damp and protected from direct sunlight for a considerable period of time. As a typical example, concrete pavements are always covered with wet straw or

burlap until the final set has taken place and there is no danger of cracking or pitting. A recent improvement is to cover the pavement with a black mastic solution, sprayed over the surface as soon as the initial set has hardened the concrete. This covering wears off after several weeks, leaving the concrete exposed; but while in place it prevents quick drying, and the concrete slab has time to cure properly.

Watertight Concrete. Watertight concrete can be made with Portland cement without special materials if the following essential requirements are observed carefully:

1. Sound, clean, aggregates that do not absorb much water.
2. Limited amount of mixing water.
3. Plastic, workable mixtures.
4. Thorough mixing.
5. Proper placing.
6. Favorable curing conditions.

These factors have already been discussed, but they are repeated here to emphasize their importance in securing waterproof concrete. It is obvious that to resist the passage of water the aggregates must be almost impervious to moisture. The amount of water used in mixing the concrete should not exceed 6 gals. per sack for thin concrete sections, or 7 gals. per sack for concrete in large masses. A plastic, workable, but not sloppy mix, produced by thorough mixing in uniform batches, can be compacted in the forms without difficulty. Placing it, layer by layer, in the forms, should be a continuous operation whenever possible. The other requirements for waterproof concrete can be nullified completely by careless curing, or stripping the forms too soon. Concrete should be kept damp for a period of 10 days to 2 weeks in all but freezing weather. In cold weather concrete should be protected by covers of straw, earth, or tarpaulins until cured.

Waterproofing Compounds. There is another method of waterproofing concrete, known as *integral waterproofing*. This consists of adding a specially prepared compound to the batch as it is being mixed. Some manufacturers offer special cements to which the waterproofing agent has already been added. Calcium stearate is one of the most common of these agents, but numerous other chemicals are available in powder, paste, or liquid form. The purpose of these special agents is to fill the pores of the concrete, thus preventing the passage of moisture. The manufacturer always includes specific directions for the use of the waterproofing compound. If these instructions are followed carefully the result should be a complete success. No special tools or machinery are necessary.

Membrane waterproofing, when properly done, yields most consistent results. Membrane waterproofing is constructed in place by building up a strong, waterproof, and impermeable blanket of overlapping sheets of tar saturated, open mesh fabric, or rag felt. The sheets are coated and cemented together with hot coal tar pitch. There is always one more application of pitch, than the number of sheets, because the work is started and ended with a coat of hot pitch, except when it is necessary to lay a dry sheet on a wet surface in order to start work. Properly constructed membrane waterproofing prevents the entrance of water regardless of hydrostatic head, capillary attraction, concrete cracks, or expansion of joints.

The materials used in membrane waterproofing are common and cheap. The costly part of the work is the labor, and the tools and machinery for heating, and for mopping the tar pitch. A skilled roofer should have no difficulty in handling this kind of waterproofing. The fabric is usually a loosely woven cloth, impregnated with coal tar pitch compound. Felt is less costly than fabric, but will not stand the strain of vibration or mass movement as well as fabric.

Concrete Work in Cold Weather. Concrete work can be carried on successfully in cold weather (when the temperature is below 35° F.), if the concrete is kept from freezing until it has had time to harden thoroughly. There are two ways to prevent freezing; by heating the materials, and by protecting the fresh concrete from the cold. In common practice, both of these steps are taken, and are continued until there is no doubt that the work has set properly. Commercial, antifreeze mixtures contain chemicals that tend to raise the temperature of the mix, and thus enable it to resist freezing until the concrete has had time to take the initial set.

In heating the materials before mixing concrete in cold weather, the water should be heated in a tank or caldron to about 150° F. The aggregates must be heated thoroughly before they are mixed. A simple method of heating them is to heap the sand and coarse aggregate in separate piles over sheet steel pipes and then build a fire in the pipes. Another method, which is more costly, is to use a gasoline or oil burning torch, mounted on the mixer, and placed so that the flame will shoot into the revolving drum as it tumbles the batch.

All freshly poured concrete must be protected from the cold as soon as it is poured. For thin work or floors where the mass of concrete is small, it is customary to enclose the work with temporary shelters of canvas, tarpaulins, or building paper supported by 2 × 4's. Small stoves or *salamanders* (sheet steel stoves) may be used to raise the temperature just above freez-

ing. It is extremely important to leave the forms in place longer than usual, until the concrete has set, and begun to cure.

Surface Finishes. The exposed surface of concrete may be finished in a variety of pleasing ways. The simplest and easiest surface finish is that imparted by the form itself. The appearance of this finish may be smooth or rough, it may show wood grain, or it may be panelled or grooved as desired. Plywood gives a very smooth finish, that makes it almost unnecessary to treat the surface of the concrete if the work is done carefully.

A smooth and cheerful finish may be applied to rough concrete by giving it a coat of cement paste, just after the forms have been removed. The paste, either of gray or white cement as desired, is mixed to the consistency of thick cream, and applied with a wide brush over the damp surface of the green concrete. When hard the paste will resemble a hard plaster finish.

Floors, sidewalks, and other flat, concrete surfaces exposed to wear should be finished smooth and level with a steel trowel or wooden float. This final work helps to compact the surface, removes hills or waves, and aids greatly in preventing excessive dusting and cracking of the concrete.

As a preliminary operation before troweling, the concrete work is struck off carefully, after it is placed in the forms or area to be floored, until all high or low places have been leveled out. This leaves a true, but somewhat rough surface that must be troweled smooth as a final operation.

The most important single factor in producing a satisfactory surface by troweling is the *time of the final finishing.* In best practice, the concrete is allowed to stand for several hours after it has been laid, until the surface is quite stiff and workable, but not set. Water or scum must not be allowed to collect on the surface during the waiting period. The steel trowel is used to compact and produce a dense surface, rather than just to smooth out the rough spots. For this reason the weight of the body must be behind each stroke of the trowel as it compacts and smooths in a single motion. Excessive troweling is likely to remove too much moisture from the mass, and thus to cause the formation of numerous fine cracks called *hair checks,* as well as excessive dusting, when the work dries out.

At times an even, gritty, nonskid surface is desired for driveways, sidewalks, or floors. To produce this type of finish, the finishing is done with a wood float, instead of the steel trowel. The result is a smooth, yet grained finish, that provides better traction than the slick finish obtained with the steel trowel.

Concrete surfaces, after thorough hardening, may be cut and tooled like natural stone. When this kind of surface finishing is desired, particular

attention must be paid to the aggregates used in the concrete, to avoid soft or brittle pieces that will not cut and finish well. Some of the most attractive finishes are the result of mixing aggregates, selected for their color or unusual shape. White sand, marble or limestone chips, granite chips, crushed feld spar, mica-spar, etc., are but a few of the aggregates that can be used. The concrete is mixed in the usual manner, with the special aggregates.

FIG. 5.5. Floating fills up the hollows and compacts the concrete. Troweling not only compacts the wearing surface but also produces a smooth finish. The finishers are bearing down on their trowels. This gives increased density.

The final operation in decorative finishing of concrete is to remove the film of cement which forms on the surface, and conceals the colored aggregate or other decorative material. After the mass has set and the forms have been removed, this surface film of cement can be removed easily, by washing with a solution of 1 part muriatic acid and 4 or 5 parts water.

Stripping Forms. Any rules for stripping forms from concrete work must necessarily be general because the time required for concrete to set depends on the weather, the formula used in mixing the concrete, and the amount of concrete used, etc. It is always better to leave the forms in place too long, than to strip them too soon, with the consequent danger of failure.

All forms, whether of wood or steel, must be constructed, placed, and braced so that they can be removed without disturbing or injuring the green concrete. If the forms are to be used more than once, care must be taken

LENGTH OF TIME BEFORE REMOVING FORMS
(From Time that Pouring of Concrete is Complete)

Type of Work	*Summer*	*Winter*
Thin walls, posts, etc.,	2 days	4–5 days
Foundation walls and footings	3 days	3–4 days
Floor slabs	6 days	2 weeks

not to damage them, while they are being removed. A pinch bar and a claw hammer are the most convenient tools for drawing nails, and prying the forms loose.

CONCRETE PROJECTS

Stoop and Steps. This project is easy to build. It is a stoop consisting of 3 steps, and is intended for installation at the rear or side entrance of a small house. It is inexpensive, will withstand hard wear, and yet retain its neat appearance.

The platform, or upper step, of this stoop is 3′ square. Each step is 3′ wide, and has an 8″ riser, and a 12″ tread. All the dimensions of this project are shown in the accompanying illustration (Fig. 5.6). Note that the foundation extends 2′ below grade (ground level).

The materials needed to build this project consist of the lumber for the forms, shown in Fig. 5.7, and the materials for making the concrete. The quantities of these materials are listed below:

BILL OF MATERIAL

Number Required	Part	Size	Kind of Material
2	Sides of Top Step	3′ 1″ × 8″ × 1″	Wood
2	Sides of Middle Step	4′ 1″ × 8″ × 1″	"
2	Sides of Bottom Step	5′ 1″ × 8″ × 1″	"
3	Front of Steps (risers)	3′ × 8″ × 1″	"
1	Brace	3′ × 4″ × 2″	"
6	Stakes for Holding Form	1′ 6″ × 2″ × 4″	"
12	Cleats	Various	"
9		Bags	Cement
36		Cubic Feet	Sand
45		" "	Gravel, a Crushed Stone
56		Gallons	Water

These quantities have been computed by the use of Table 1, page 7, which shows that a 1 : 3.75 : 5 mix is suitable for this kind of work. A batch amounting to 2 cu. yds. of mixed concrete will be obtained.

The Excavation. The first step in constructing this stoop is the excavation. It should be made at the point where the steps are to be installed. It should be 2′ deep and its dimensions are those of the lowest step, i. e.

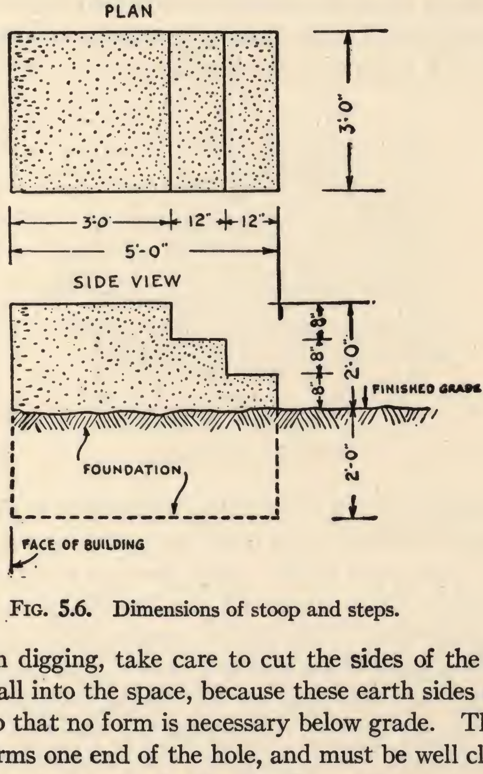


FIG. 5.6. Dimensions of stoop and steps.

5′ × 5′. When digging, take care to cut the sides of the hole so that no dirt or stones fall into the space, because these earth sides are used to hold the concrete, so that no form is necessary below grade. The foundation of the building forms one end of the hole, and must be well cleaned of all dirt so that the concrete can bond with it. Tamp the earth in the bottom of the hole, unless it is already firm, to produce a sound base for the concrete.

The Form. When the excavation is complete, work can begin on the form. Naturally, it must be made to the exact dimensions given, with all measurements made on the inside. It is usually convenient to build the form in a shop or workroom and place it on the foundation afterwards. This is easy to do, if it is nailed together securely, as shown in Fig. 5.7, before it is moved.

In building the form, nail the three side pieces together first, using the cleats for that purpose, as shown in the illustration. Then make the other side in exactly the same way. Finally, the two sides are nailed to the front pieces, the risers, which must be carefully cut to size. The joints should be made as close as possible to prevent leaks. The last step in making the form is to nail on the brace that appears in Fig. 5.7. This is the piece of 2″ × 4″ exactly 3′ long, which acts as a spreader to keep the sides of the form at the proper distance apart until some concrete is poured. Be sure to remove it before the concrete is high enough to touch it.

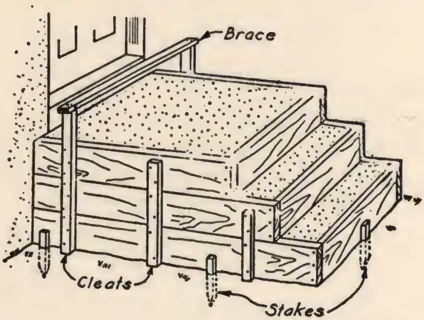


FIG. 5.7. The form.

Pouring the Foundation. The first step in concrete work is to pour the foundation, the part below ground level, and let it set for at least a day before doing the work above grade. Then the form is set in place and the job finished. To mix the concrete for the foundation, take 60% of the total materials given, that is, 5½ bags of cement, 21½ cu. ft. of sand, 27 cu. ft. of gravel or crushed stone, and 33½ gals. of water. Mix these materials, and pour the mixture into the excavation, following the methods explained earlier in this section. Remember that thorough mixing is most important. More troubles result from too little mixing than from too much. especially with stiff concrete such as is used for this job.

After this foundation has set for at least one day, set up the form on it. The form must be placed so that it is level and square with the house before it is fastened and braced firmly into place. It is secured by means of the 2″ × 4″ stakes illustrated, and also by 3 or 4 diagonal braces (not illustrated) running from the top edge of the sides to stakes in the ground outside. Put these wherever the form needs support to prevent moving, or spreading under weight of the concrete. Chips of brick or slate should be

used to wedge up the form by inserting them between the bottom edges of the side pieces and foundation. As a final check on the form after it has been placed in position, but before the stakes and braces are secured, measure the diagonals across the square that will form the stoop. If both are the same length the sides are square, parallel, and ready to be fastened into position as rigidly as possible.

Platform and Steps. When the form has been properly placed, the next step is to spread a thick cement paste over the concrete foundation to bond it with the new concrete for the steps. To make this, mix ½ bag of cement with 3 gals. of water. Then spread the paste evenly over the top of the foundation. This is done immediately before pouring the final batch of concrete, which is prepared by mixing the remainder of the materials, 3½ bags of cement, 14½ cu. ft. of sand, 18 cu. ft. of gravel or crushed stone, and 22½ gals. of water. This pouring must be done very carefully to avoid hitting or jarring the form out of position. After the operation is complete, the form should be filled to the top of the steps and platform. If water collects on these flat surfaces it should be removed with a sponge or brush, so that the concrete is left moist, but never puddled.

As soon as the concrete has set a little, that is, after a few hours, the platform and steps may be finished with a wood float, as described on page 14. This produces an even, yet gritty surface that is not slippery in wet weather. A small trowel or dull knife blade should be run along the inside edge of the form between the boards and concrete to make a smooth and slightly rounded edge on all exposed surfaces.

Leave the form in position for a week. Then remove it, and cure the concrete by covering it with straw, or burlap bags, and keep damp for a week or 10 days. After this curing, the work is ready for use. If desired, an additional finish may be applied by stripping the forms after 24 hours, and trowelling a thick cement paste onto the damp concrete with a wood float. After this finish has had time to harden, the work is cured in the usual manner.

Flagstone Walk. This is one of the simplest projects. It is often desirable to construct a walk of stepping stones of the flagstone type, where a solid walk would mar the appearance of the grounds.

The simple wood forms for making these concrete stones are shown in Fig. 5.8. The stones are of different sizes, so that an interesting and convenient pattern may be laid with the least effort. No foundation is required for these flagstones.

The form must be used several times to produce the required number of

flags, so it must be made so that it can be taken apart easily without ruining it. This is accomplished by leaving the nail heads projecting about ¼″, so that they can be withdrawn with a claw hammer after the concrete has set and hardened.

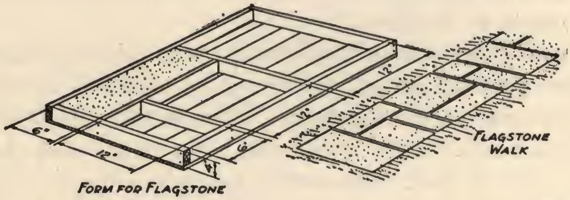


FIG. 5.8. Method of constructing forms for flagstone walk.

The only materials required are the lumber and nails for the form and the concrete materials. Ordinary 2 × 4's and rough ⅞″ boards are all that are needed for the form.

BILL OF MATERIAL

Number Required	Part	Size	Kind of Material
2	Ends	21″ × 2″ × 4″	Wood
2	To divide inside	19″ × 2″ × 4″	"
1	To divide inside	12″ × 2″ × 4″	"
2	Sides	36″ × 2″ × 4″	"
2	Bottom	38″ × 4″ × 1″	"

The form holds 1¼ cu. ft. of concrete. The 1 : 2.5 : 3 mix is recommended for this work in Table 1, page 7.

A 1 bag batch requires 1 bag of cement, 2½ cu. ft. of sand, and 3 cu. ft. of pebbles. This quantity will be enough to fill the form three times.

The first step is to prepare the form on some level space. Note how the 4 outside pieces are fitted together to make the edges easy to take apart. It is not necessary to remove the divider pieces, so these may be nailed firmly to the bottom boards. Leave the nail heads projecting about ¼″, when nailing the outside pieces together. Do not nail the bottom to the 4 outside pieces, although a few nails may be used to tack the ends only.

Oil the inside of each space with crude oil, or used crankcase drainings to prevent the concrete from sticking.

The concrete is placed carefully in each space, and smoothed off with a

wood float as soon as it is hard enough to take a finish. After standing at least 2 days the forms may be opened; by removing the side and end pieces carefully, and slipping the flagstones out of the spaces. They should be set aside in a protected place, and cured for a week or 10 days under wet burlap or straw until hard.

Each stone should be bedded in an inch of sand when the walk is built. This permits drainage of water from under the stones. Place the stones at least 2″ apart, to permit grass to grow between them.

A Shuffle Board. The equipment for this simple and popular game is very easy to build. It is a continuous slab of concrete with the score lines painted or grooved upon it. It may be built very cheaply, will withstand continuous use, and yet will remain in good condition for a long time.

The dimensions of the slab, and its markings are shown in Fig. 5.9. It may be built at ground level or slightly above grade as desired. In the latter case, a painted wood edge will add to the appearance of the slab.

The materials needed for this project are merely the wood for the form, paint, if desired, for the game lines and the materials for making the concrete. These quantities are listed below:

Bill of Material

Number Required	Part	Size	Kind of Material
6	Long Sides	16′ × 2″ × 4″	Wood
1	End (Make Two)	12′ × 2″ × 4″	"
36	Stakes	15″	"
26		Bags	Cement
58		Cubic Feet	Sand
60		" "	Gravel or Crushed Stone
108		Gallons	Water

These quantities have been computed by the use of Table 1, page 7, using the mixes suggested for a two course driveway. The top is a 1 : 2 mix, while the base is a 1 : 2.5 : 4 mix. Although the mixes differ, the quantities above are the total amounts required for both.

The Base. The concrete slab must be laid over a porous base that permits rapid drainage. This prevents cracks and uneven settlement. Five cu. yds. of pebbles or cinders are required. The first step is to excavate a shallow trench 6″ deep, 6′ wide, and 45′ long. It may be necessary to change the grades of the surrounding ground slightly, but when finished the bottom

of the trench must be level. Fill it with a bed of cinders or pebbles and roll this filling with a garden roller until the bed is so firm that walking on it does not produce footmarks. This operation is very important. Hollows and high spots can be detected by testing occasionally with a long straight-edge, and should be leveled.

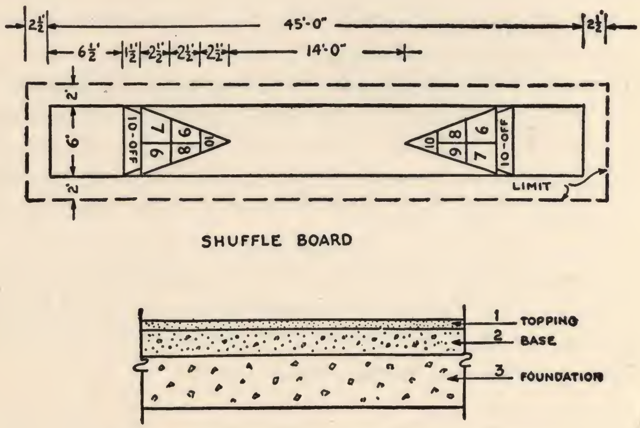


FIG. 5.9. Dimensions and slab for shuffle board.

The forms for the slab can be placed as soon as the foundation is finished. Three 2 × 4's, fastened together butt to butt with short pieces of boards form each of the long sides. The two ends should be cut exactly 6′ long and nailed between the side pieces, so that the *inside* length of the shallow box is exactly 45′. Square up the form by using a carpenter's steel square, so that the corners are square and all sides are parallel Drive stakes into the ground along the outside of the 2 × 4's, and nail them firmly to the sides and ends after leveling the entire form with a spirit level. It is most important that the finished form be square and level.

Pouring the Concrete. As this is to be a two course slab, the first or base portion must be poured first. Mix the concrete according to the directions given earlier in this section. This part of the job will require 15 bags of cement, 37 cu. ft. of sand, 60 cu. ft. of gravel, and 54 gals. of water. Do not disturb the form or concrete for at least a day after this portion of the project has been finished.

After the base has set, the final thin coat is applied to finish the slab. This requires 11 bags of cement, 21 cu. ft. of sand, and 54 gals. of water. Mix this *topping* thoroughly, as directed earlier in this section, and spread

it evenly over the base course until it is level with the top of the form. Strike off all hollows or high spots with a straightedge by working along the form from end to end with a straightedge that is just long enough to span the 6′ width of the slab. Allow this coat a few hours to set and then trowel it to a very smooth and even finish with a steel trowel or float.

Leave the form in place for a week while curing the concrete by covering it with damp straw or burlap. After the concrete is cured and dry the lines for the game may be painted on the concrete surface, using the type of paint that is sold for marking roads. This will last much longer than ordinary paint, and it does not smudge or wear thin. It should be allowed to dry before the slab is used for games.

The form may then be removed, or may be left in place if it was built neatly. A coat of paint will improve the general appearance of the wood edge and also preserve it.

Concrete Sidewalk. A concrete sidewalk is a permanent improvement that enhances the value of property. The sidewalk shown in Fig. 5.10 is 75′ long, 4′ wide, and 4″ thick, with a slight crown to shed water. The reader may change these directions and quantities to suit his own needs. While the walk shown is considered suitable for public as well as private use, some communities have definite standards and specifications that govern all public sidewalks. These must be observed carefully whenever local improvements of this nature are installed or rebuilt.

Plain concrete slabs are not designed to act as bridges. Therefore the subgrade must be solid. If the slab is to be laid directly upon the ground, without any base of cinders or gravel, all soft spots must be tamped until firm. This is very important. If the soil is sandy the concrete may be placed directly upon earth, otherwise 6″ of cinder or gravel must be provided as shown in Fig. 5.10, Section A-A. This drains off water, and so prevents the cracking that results when ice forms under the concrete.

Slabs are best built in one course construction, which means that the full thickness of concrete is placed at one time using the same mix throughout. To provide for the necessary expansion joints as shown in Fig. 5.10, Detail c-c, the work must be divided at 4′ or 6′ intervals. An expansion joint that is ½″ wide must be provided every 50′ as shown in Fig. 5.10, Detail b-b.

When walks are built around or within a few feet of trees, some extra space must be left for growth of the roots, to prevent them from raising or cracking the concrete slab.

The *tools* and *materials* needed for this project are those used on any small concrete job: shovels, hoe, pails, mixing floor, measuring box, tamper,

straightedge, and the two cement finishing tools: a wood float, and an edging tool. A few carpentry tools and a level are needed for making the side forms. About 60 board feet of 1 × 4 lumber are needed for the side forms, stakes, and separator pieces. The recommended mix in Table 1 for a one course sidewalk is 1 : 2.5 : 3.

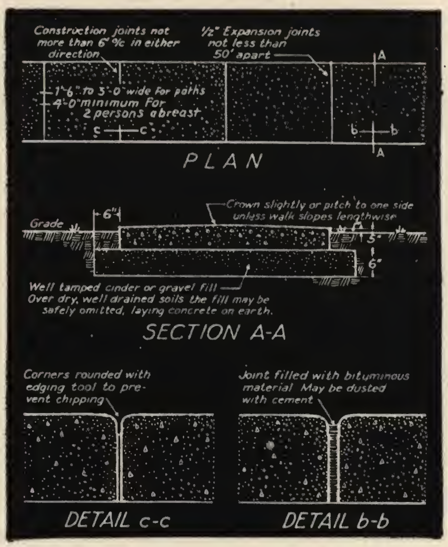


FIG. 5.10. Concrete sidewalk.

The lumber requirements for the forms are: 160 running feet of 1 × 4 boards in convenient lengths (4′ long will do), 40 stakes, and 20 spreaders, 2″ × 4″ × 4′ long.

The required amounts of materials are: cement, 24 bags; sand, 60 cu. ft. or 2¼ cu. yds.; gravel, 71 cu. ft. or 2¾ cu. yds. of gravel and 104 gals. of water. The sub-base requires 150 cu. ft. or 5½ cu. yds. of cinders or gravel. These quantities are net quantities, and do not therefore include an allowance for job waste.

Forms. The first step is to excavate a shallow trench 75′ long, 5′ wide, and 10″ deep. The bottom should be rolled or tamped thoroughly and then filled to a depth of 6″ with a solid layer of cinders or gravel. This sub-base must be rolled and tamped carefully to compact it and to remove any obvious hollows or high spots. The side forms may now be set in place on the sub-base.

As shown in Fig. 5.11, the 4″ strips of wood that form the slab are parallel and level according to the desired finished grade of the sidewalk. They are held in place by stakes driven at 4′ intervals along the outside. After the top edges have been leveled up to the desired grade the forms should be nailed to the stakes. Every 6′ a spreader piece 4′ long is fitted at right angles between the side forms but is not nailed to them. These spreaders should be held firmly to stakes, so that they may be removed easily without disturbing the forms or concrete. Three of these spreaders are shown in Fig. 5.11 as well as the stakes holding them in position. A wooden straight-edge to strike off the crown of the walk must be prepared before any concrete is poured. This is a piece of 1 × 4 board about 5′ long, with one edge planed out to a slightly concave curve, not more than ½″ deep. This will shape the crown of the sidewalk when used as a strike board on the wet concrete.

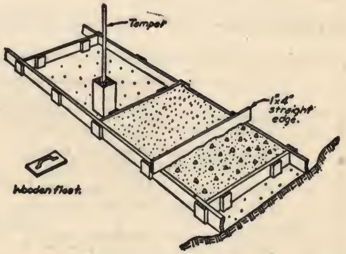


Fig. 5.11. Forms and method of building one-course sidewalk.

Placing the Concrete. The instructions for proportioning, mixing, and placing concrete discussed in previous sections should be observed carefully. Table 1 gives the mix that has been found economical and durable for this class of work. The form must be filled with concrete in two separate steps. Every *other* section must be filled and allowed to harden, *before* the intervening sections are poured. This method creates separation joints between sections to allow small movements to take place without cracking the slabs. Figure 5.10 shows several construction joints in plan and in section. The full expansion-joint shown in Detail b-b is formed by using a board ½″ thick between adjacent sections and allowing it to remain in place until the slabs have hardened sufficiently to permit its removal without breaking the edges of the concrete. This type of joint must be introduced at least once in every 50′ of sidewalk to take up the expansion and contraction that occurs with changes of temperature.

After the concrete is poured, it must be struck off with the strike board to form a slight crown on the walk. The concrete is spread and crowned slightly at the middle by eye while the strike board is worked slowly along the side forms as shown in Fig. 5.11. High or low spots can be eliminated very easily in this manner.

After allowing each alternate section to set for a few hours the surface

finish is completed with the wood float until it is even and slightly gritty. Care must be exercised to keep the slabs crowned while the wood float finish is being worked up.

Finishing and Curing. After several alternate sections have been finished as described above, the intervening sections may be completed. The separator boards must be removed carefully before this is done. With both ends of a section completed, and the side forms still in place, it should be a simple matter to pour and strike off each of the remaining slabs. A little care in striking off the crowns so that they line up neatly with those already finished will produce the appearance of one continuous piece of work.

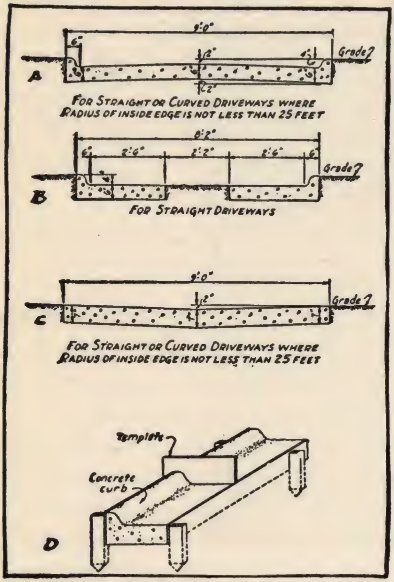


FIG. 5.12. Designs for several types of concrete driveways.

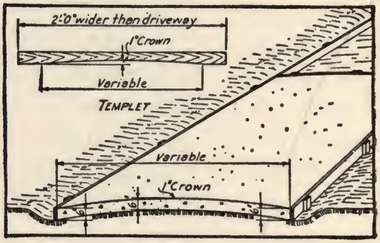


FIG. 5.13. Method of constructing pavement type of driveway with crown.

As soon as the alternate sections have hardened sufficiently, they may be finished with the wooden float to match the rest of the sections. Just before the concrete is too hard to take an impression every section should be edged along all sides with a cement finisher's edging tool, to give the sharp edges a slightly rounded finish. This prevents chipping and little cracks at the sides and joints between sections.

After all the sections have been laid, finished, and jointed, the entire walk must be covered with wet straw or burlap, and kept moist for a week or 10 days. In very hot weather it may take longer to cure, because the moisture in the covering evaporates quickly.

After all the concrete slabs have been cured the covering is stripped off and the side forms are removed carefully. All joints between sections may

now be cleaned out, and dusted with a little cement to improve their appearance. The large ½″ expansion joint or joints should be filled with mastic or bituminous cement as shown in Fig. 5.10, Detail b-b, and then dusted with Portland cement.

The excavated dirt may now be used to bring the grade up to the edges of the sidewalk. If water is sprayed or poured over the loose earth as it is leveled off along the sidewalk, it will pack down better.

Chapter 2

PLASTERING

Plaster Bases: Wood Laths, Plaster Boards, Rigid Insulating Laths, Expanded Metal Lath, Expanded Corrugated Lath, Wire Lath, Special Forms . . . Applying Wood Lath . . . Applying Other Plaster Bases . . . Applying Wire Lath . . . Estimating Lath Requirements . . . Final Steps in Lathing . . . Plaster: Covering Capacity, Finishing . . . Mixing Plaster: Scratch and Brown Coats . . . Estimating Quantities . . . Applying Plaster . . . Mixing and Applying the Finish Coat . . . Plastering Troubles

Plastering consists of applying several coats of prepared mortar to a reinforcing base or wall surface that has been designed or prepared especially for this purpose. The plaster mortar usually consists of gypsum or lime, water, and sand, to which fiber is often added. Many surfaces cannot be used as a plaster base, because plaster must form a mechanical bond with the surface over which it is spread. Thus, a polished, oily, or chalky surface invites failure from the very beginning.

Plaster may be spread directly over brick, stone, terra cotta tile, or concrete exterior walls, but some provision must be made to protect the finished plaster from moisture penetration through the walls. A common practice is to spray or paint the inside face of the wall with a good coat of asphalt waterproofing compound to seal the surface before plastering. Another method uses patented terra cotta furring tiles to create dead air spaces between wall and plaster. The oldest method, however, is the furred wall in which narrow strips of wood, nailed vertically, create a space between the back of the plaster and the face of the wall itself. Unless adequate provision is made against moisture penetration, it is very poor economy to plaster directly on the inside surface of an exterior masonry wall. The slow penetration of moisture will weaken the bond between wall and plaster until complete and costly failure occurs.

Plaster Bases. By far the most common plaster base is lath of some type secured directly to wood studs or furring strips. No special skill is required to do a good job, providing the walls, partitions, door and window openings, etc., have been built true and plumb. In some parts of the country lathing is a separate trade, with special emphasis on metal lathing. However, with

ordinary care and attention to the methods outlined in the following pages of this chapter, the amateur plasterer should be able to do a workmanlike job of lathing walls and ceilings.

The following laths are in common use. Each has some particular merit, such as low initial cost, insulating value, reinforcement against plaster cracks, etc.

FIG. 5.14. Rigid insulating lath.

Wood laths are strips of spruce, cypress, or white pine, 48″ long, 1½″ wide, and ⅜″ thick, free from knots, sap, and bark. They are usually sold in bundles containing 100 laths. The most common length is 4′, as this permits proper nailing to wood studs having the usual spacing of 16″ between centers.

Plaster boards are rigid sheets of gypsum, with a paper or fibrous covering to protect and reinforce the core. Sheets may be smooth or rough faced, solid or perforated with holes as in Figs. 5.14, 5.22, for the plaster key. There are several standard sizes, such as 32″ × 36″, 16″ × 32″, 16″ × 48″, ranging in thickness from ¼″ to ½″. The fire-resistant quality of this lath gives extra protection to frame buildings.

Rigid insulating laths are of many types and sizes, but they usually are compressed fiber insulating boards, treated to make them bond perfectly with the first coat of plaster. It is customary to cover all joints and angles and the spaces around all door and window openings with strips of wire mesh as shown in Fig. 5.15. This eliminates the possibility of cracks at the joints. There are several thicknesses of rigid lath available, but the ½″ and the 1″ sizes are most common. The standard length is 18″ and the standard width is 48″ with the edge beveled or shiplapped to make a good joint between pieces.

Expanded metal lath is the familiar diamond mesh lath (Fig. 5.16) used throughout the world. It is available in several different gauges but all approximately 2′ wide by 8′ long, with 9 sheets packed in a bundle. The

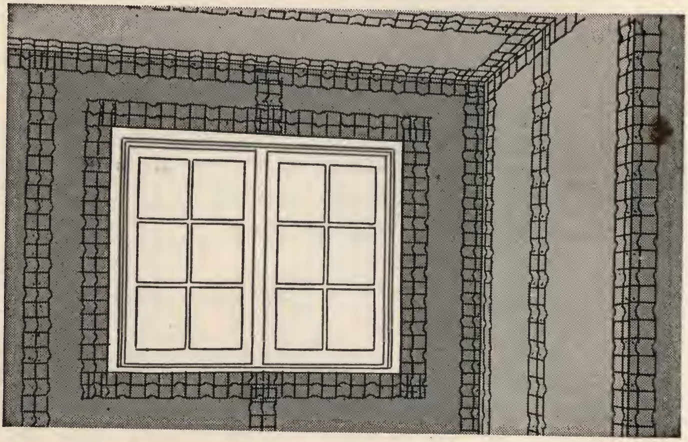


FIG. 5.15. Wire mesh covering joints in lath. *Courtesy U. S. Gypsum Co.*

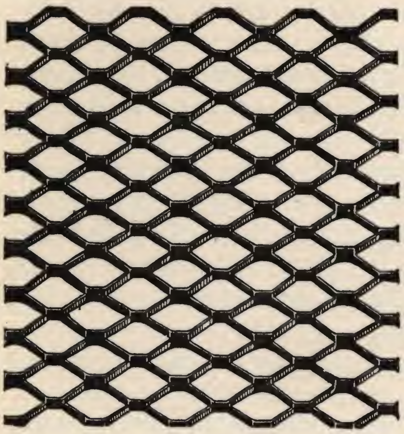


FIG. 5.16. Diamond mesh lath.

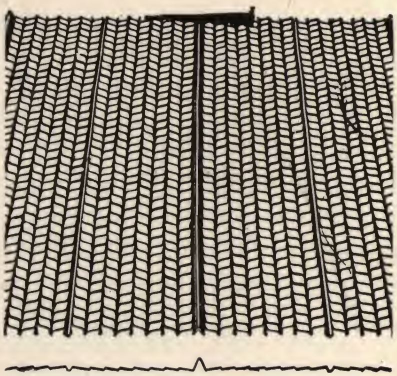


FIG. 5.17. Expanded corrugated lath.

term *expanded metal lath* is used to indicate a metal lath that is made from sheet metal, slit and then expanded into such form that there is no rib in the lath. The lath is available in the following finishes: regular painted steel, copper bearing steel, galvanized steel, and pure iron, or special steel.

Expanded corrugated lath (Fig. 5.17) is similar to the flat expanded lath, except that corrugations or high ridges are added, running longitudinally, making the lath self-furring. The ridges also add stiffness without increasing the weight, thus enabling one man to handle the sheets with ease. Flat rib metal lath is sometimes called *economy lath,* as it is designed to cut down the amount of plaster used in the first coat to make the plaster *keys.* This lath is made in same variety of steels and finishes as the flat lath.

A new development in plaster bases is a welded wire mesh lath with a heavy fibrous backing. The steel mesh in it is designed to reinforce the plaster slab as does the steel in reinforced concrete. It is claimed that this system minimizes lath and stud strains and thus prevents plaster cracks.

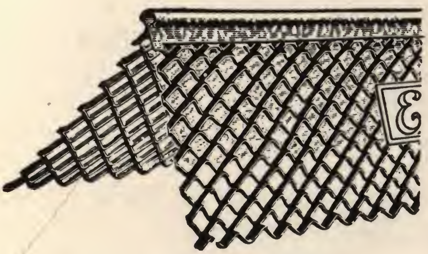


FIG. 5.18. Corner beading.

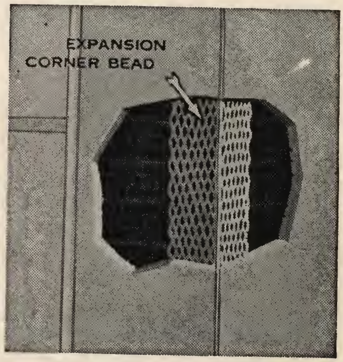


FIG. 5.19. Cutaway showing corner bead.

Wire lath is available in a number of forms. The tensile strength of wire is considerable, so the development of a woven grid of wire for use as a plaster base has produced several excellent systems. Wire lath is available in several standard weights, finished plain, painted, or galvanized, with or without a fibrous sheet backing, which may be treated to act as an insulating medium if desired. There is a size, type, and finish, for practically every condition encountered in plastering.

Corner Beads, Picture Molding, and Special Forms. It is necessary to reinforce or protect sharp corners, breaks, or other structural or decorative members when formed in plaster. Special sheet metal or expanded metal shapes have been developed to reinforce corners, both inside and outside. Corner beads (Figs. 5.18, 5.19) are made in standard lengths so that they can extend from floor to ceiling in one piece. Nailed to the corner studs, plumb,

and true to the desired plaster finish, they form a clean and true corner that could not be produced easily by solid plaster alone. In fact, in a corner with no reinforcing the slightest blow will cause an unsightly crack or break.

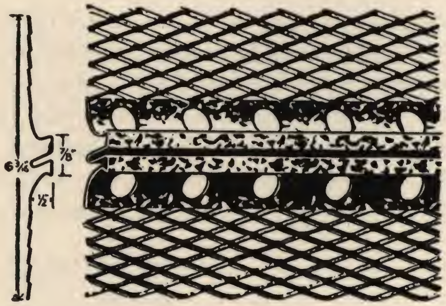


Fig. 5.20. Metal picture molding.

Metal picture molding (Fig. 5.20) that acts as a ground as well as a means of holding picture hooks may be installed at any desired height. It is fastened permanently to the studs as the lathing is being installed. The plaster conceals it completely with the exception of the narrow slit into which the hooks are placed.

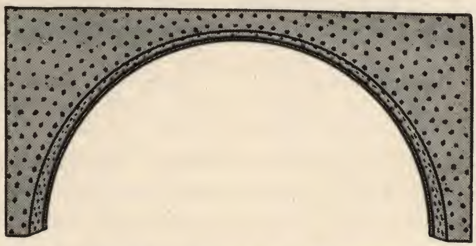


Fig. 5.21. Metal form for arches.

Metal forms for arches, round headed openings, etc. (Fig. 5.21), form a much better opening than wood forms made on the job. The saving in time and labor as well as the greater strength imparted by the one piece metal form, more than repays the slightly higher cost of these items.

Applying Wood Lathing. Wood laths must be nailed to solid supports, furring strips on masonry or wood structural members, such as 2 × 4's or beams. The following method of wood lathing will give good results: All wood laths must be soaked in water for at least a day just before they are

nailed in position, so that the lath and plaster may dry out together for best results. Start the lathing in one corner near the ceiling, and work around or down, as convenient. Stand a small bundle of the wet laths on end, within easy reach. Place a pinch of lathing nails (3-penny nails, see Woodworking Section) in the hand, and begin by nailing the first lath horizontally to the wall. A lathing hatchet (Fig. 5.22) saves a great deal of time because it can be used to cut the laths quickly to just the right length, as the work progresses around door or window openings or other irregular spaces.

FIG. 5.22. Applying plaster base.

Nail the laths in groups of 8 or less, spacing them not less than ¼″ nor more than ⅜″ apart. It should be possible to slip a pencil easily between the laths. Into these spaces the *key* or ridge of plaster will be squeezed to hold the base coat, and with it all other coats, in place on the wall. Nail every lath every time it crosses a support, with all nails driven firmly into place. In every case nail at the *middle* of a lath first, and then nail down the ends with two nails. Fit around all openings for plumbing, electrical, or other installation as neatly as possible. Use long length lath with a nailing on at least two points, whenever it is necessary to lath a space of less than full lath length. Avoid short lengths, split pieces, or makeshift lath, because these invariably cause trouble later.

Avoid long vertical joints by *jumping* each group of laths one stud or support, so as to produce a staggered effect. Each inside corner must be nailed against solid support. If such support is lacking when the lathing reaches the corner, nail a 1″ × 2″ strip or strips against the stud or wall so that a good corner nailing surface is ready for the lathing. Avoid breaks or lath joints at the corners of door and window openings, by nailing full length laths so that they extend at least one support length beyond the jambs or sides of the space. This helps prevent plaster cracks at corners.

Applying other Plaster Bases. Gypsum lath or plaster boards as they

are called in the trade, are intended to be nailed directly to the studs or furring strips. The horizontal joints are kept even, while the vertical joints are broken at all points. All inside breaks or corners are reinforced with continuous strips of metal lath to prevent corner cracks. In nailing, the boards are placed with the plastering side out. The center of the board is nailed first and the edges last. Do not wet the boards before plastering.

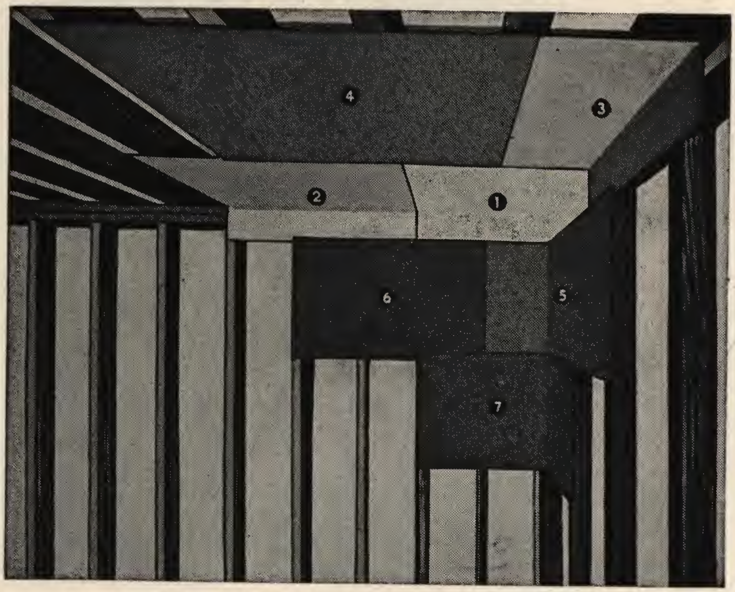


FIG. 5.23. Lathing sequence. Start lathing on ceiling at corner of room as shown in this drawing. Sheet Number 1 is the key sheet. Complete lathing on ceiling, then start on the side wall.

Rigid insulating lath is applied in exactly the same manner as gypsum lath. Some types have a bright surface on one side that acts as the insulating medium. In applying this lath, the bright surface must be placed toward the outside. It is used on exterior walls only.

In general, except for rare conditions that require a room to be well insulated on all 4 sides, insulating lath is applied to *exterior* walls only. The balance of the partitions, ceilings, etc., may be lathed with some less expensive type of lath.

Expanded metal lath comes ready to use. It is nailed every 6″ to the wood studs or furring strips. The sheets are applied horizontally, with all

edges lapped at least 2″. Care should be taken to turn all corners, both inside and outside, so that the sheets lap at least one stud. No sheets should meet at a corner, and continuous vertical joints must be avoided by staggering.

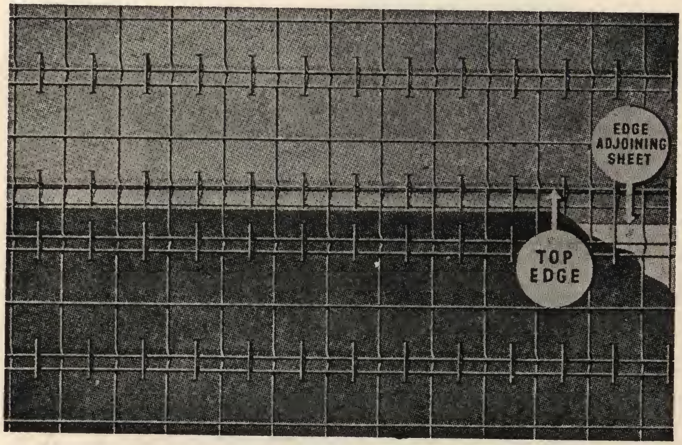


Fig. 5.24. Lapping.

Lap all sheets so that the reinforcing steel extends across all joints. This provides continuous reinforcing and protects plaster against cracks. On sidewalls lath from ceiling down and lap top of sheet over bottom of the upper sheets. Make all laps both vertical and horizontal at least 1″ and lap wire over wire.

Applying Wire Lath. Wire lath, both plain and paper backed is applied by the method shown in Fig. 5.23. All types of metal lath should be put up in this manner, to prevent waste of material, as well as to obtain smooth, even joints where sheets overlap. Note that the sheets are long enough to span 4 studs spaced 16″ on centers. This is standard practice.

Figure 5.23 shows how to start with a corner piece. Figure 5.24 shows the correct way to lap two sheets, while Fig. 5.25 shows the type of nail usually furnished for this work.

Estimating Lath Requirements. It requires 1500 standard wood laths and 10 lbs. of 3 penny lathing nails to lath 100 sq. yds. of surface. The allowance for waste is usually 5%, to allow for lathing around openings where short lengths must be used. This waste allowance must be added to the net quantity of lath estimated for a job. The resulting sum is the quantity to be purchased.

Wire lath and expanded metal lath are nailed to wooden studs, furring strips, beams, etc., with 1¼″ galvanized wire staples spaced about 6″ apart. When steel furring strips or other metal supports are used, the metal lath

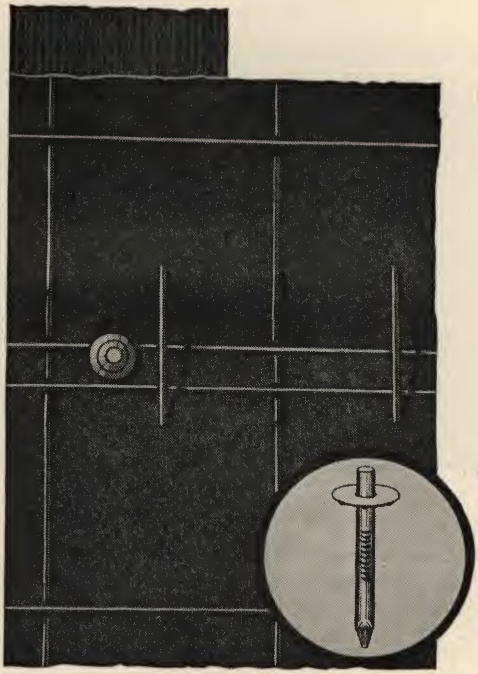


FIG. 5.25. Paper backed wire lath and type of nail used

Nailing. A lath nail is recommended for the application. This nail is blued, sterilized, of 11 gauge by 1⁵⁄₁₆″ in length.

Drive the nail so that the collar fastens the reinforcing wire at the center of the crimp in the manner illustrated. Nail into every stud and joist on both ceilings and sidewalls at every rib formed by the crimped wires.

Other types of nails may be used provided they penetrate the wood a full 1″ and securely engage the reinforcing wire. This would include 4-penny common or box nails, (bent over the wire) 1⅛″ blued hook-head nails, 1¼″ blued ⁷⁄₁₆″ head plasterboard nails and 1″ blued metal lath staples. *Courtesy of Pittsburgh Steel Co.*

must be laced into place with special 18 gauge wire made for this purpose. Ordinary wire must not be used, because it will rust through and cause plaster failures in a comparatively short time. Paper-backed wire lath,

however, should be fastened with the special nails shown in Fig. 5.25, according to the manufacturer's directions.

AVERAGE QUANTITIES OF WIRE OR STAPLES
PER 100 SQ. YDS. OF METAL LATH

Furring Spacing	No. 18 Wire, Lbs.	1¼″ Staples, Lbs.
12	6	9½
14	5	8
16	4½	7

Metal lath, 97″ long and 24″ or 27″ wide, is packed in bundles of 9 or 10 sheets, depending on the size and the manufacturers standard bundle. Each sheet is designed to cover approximately 2 sq. yds. of surface, not counting the necessary lap all around over the adjoining sheets.

In every case, take off the areas of wall or ceiling surfaces in square feet; deduct for all openings (finished sizes), and then add 5% for waste. Reduce the total to square yards and then divide by 2. This will give the number of sheets required for the job. Estimate the quantity of staples or wire necessary to fix the lath in place, and order by the bundle of lath and pound of fastenings. It is usually impossible to buy part of a bundle of metal lath.

Final Steps in Lathing. After the large flat surfaces, such as walls and ceilings, have been lathed, there are a number of incidental fixtures and guides for the plasterer to be installed. These include picture molding, metal forms for arches, corner beads, and other incidentals, which have the important secondary purpose of serving as a guide to the correct thickness of plaster.

Grounds. It is also necessary to install a number of temporary pieces of wood, or lath, to serve as guides for the plasterer. They are called *grounds* and are usually strips of wood 2″ wide and ⅞″ thick, that act as gauges to keep the plaster true and straight from corner to corner, or from ceiling to wall. Grounds for baseboard, or temporary pieces around door and window openings should be installed by the carpenter. All openings that are to be finished with trim must have temporary grounds, to ensure that the finished plaster and the finished trim will meet in a common plane surface. A single strip of ground is nailed about 6″ above the floor all around the room. It provides a very convenient nailing base for the baseboard or trim and pro-

vides a guide for the plasterer to use in rodding and smoothing the soft plaster to a straight vertical plane.

Common wood laths may be used as grounds around door and window openings. They are nailed to the edges of the studs that form the rough openings so that they project out beyond the lathed surfaces just the thickness of the plaster. These grounds must be plumb, and line up with the base grounds neatly.

Install all grounds straight or plumb as required, by using a line on the horizontal work, and a long level or plumb rule on the vertical strips. Each strip must be nailed firmly to the permanent wall or partition structure. Hollow places should be brought out to the line, straight and true, by driving small wedges between the wall and ground. High spots must be removed by chopping off just enough wood from the *back* of the wood ground strip to bring the front surface back into line when the ground is nailed into place.

Picture Molding and Corner Beads. Now set the picture molding, metal corner beads, forms for arches, and other incidental fixtures. As stated above, metal picture molding serves as a ground to guide the plasterer, as well as an almost invisible slot for picture hooks after the plastering is finished. The strips of picture molding come ready to be installed, except for cutting to exact lengths to fit the walls. It is necessary to install the molding level and true, with all corners mitered neatly. It should be nailed firmly to every stud to prevent cracking at the plaster edges when heavy pictures are hung from the slot. Figure 5.20 shows a common type of metal picture molding.

Corner beads must be installed very carefully to ensure plumb and square corners. Bends or breaks should be eliminated, and the bead left clean and straight to serve as a guide for the plastering.

The metal forms for arches, rounded or curved heads, etc., are placed, lined up, and nailed after the walls are lathed. Care should be taken that the beaded edges are not marred. This prevents accidents or breakage to these special pieces, and permits adjustment of parts to ensure smooth and perfect curves.

After all lathing has been completed and the grounds installed, all debris should be removed and all glass or fixtures protected by paper or wood covers. The job is now ready for the plasterer. After all the plastering has been finished and allowed to set, the temporary grounds must be stripped off carefully. This includes especially the grounds around door and window openings, which upon removal, will leave the plastered wall openings ready for door frames and window trim.

Plaster may be defined as a mixture of sand or some other inert substance (which may contain a fibrous material), water, and a binder such as lime or gypsum. These materials form a mixture which is initially plastic and easy to apply, and which, when set and hard gives a smooth surface to walls and ceilings. Plaster serves as a background and support for the decorative treatment and seals each room or space against drafts, dust, and noise. Although not fireproof in itself, it retards the spread of fire and is reasonably soundproof without special treatment. For hygienic reasons it must be washable and fairly impervious to ordinary odors that occur in the home.

At the present time, the most widely used binder in plaster is the mineral gypsum, which has been partly dehydrated, and which recombines with water and sets to a hard mass. It effectively binds together any inert materials such as sand or fiber which may be mixed with it, if the proportion of such materials is not too large.

The purpose of adding sand is to give bulk, and the purpose of adding fiber is to give increased strength when necessary, such as in the first coat of plaster. The proportions in which the sand, gypsum, and water are mixed depend on the type of surface to be covered and the number of coats of plaster to be applied. These proportions will be given in detail in the specific directions on the following pages.

Practically all gypsum plaster is sold in 100 lb. paper sacks ready for use. A few of the plasters in greatest demand are: plain or unfibered plaster, fibered plaster, prepared plasters with added sand, and finishing plasters. Sand must be added to the plain or fibered plasters on the job; sanded plasters need only water to make them ready for the wall. The finishing plasters cover a wide range of finishes, colors, and special uses, but in every case they are intended for the final coat of plaster that is to be painted or decorated. The sanded plasters have had clean, sharp sand added by the manufacturer to ensure the correct proportions. They are excellent for use where good sand is difficult or expensive to obtain.

The sand must be clean and sharp. It must feel definitely gritty to the touch for best results. Bank run sand is not recommended unless it has been screened very carefully to remove the small grits and leaf mold. In the long run it is safer to buy washed sand than risk plaster failure with dirty material.

The mixing water must be clean enough to drink, which means free from oil, dirt, or coloring matter.

Covering Capacities of Plaster. Table 1 gives the average covering capac-

ity of gypsum cement plaster over several different types of lath. Table 2 gives the average covering capacity of fibered gypsum plaster over several different types of lath. Table 3 gives the average covering capacity of sanded gypsum plaster over several different types of lath. These tables refer to the scratch and brown coats only. In every case the materials are proportioned by weight. A rough but practical rule is: three 10 quart pails of *dry* sand weigh 100 lbs.

Finishing Plaster. The materials for finishing plaster are entirely different from those used in the base coats, because no sand is added to the gypsum cement unless a sand finish is desired. A few of the standard finishing plasters are: prepared gypsum; gauging plaster and lime mixed; colored finish plaster and water-resistant plaster. All may be purchased in paper sacks ready for use.

Prepared gypsum finish requires only the addition of water to make it ready for use. When a sand finish is desired, selected clean silica sand is added in equal proportions to the gypsum finishing plaster.

Gauging plaster is used only with lime putty finishes. This mixture, in the proportions of 1 part by weight of gauging plaster to 2 parts of lime putty, is the most common white finished plaster in use today. A batch of 300 lbs. (1 bag of gauging plaster to 4 bags of hydrated lime) will cover about 60 sq. yds. of wall surface with 2 thin coats.

Colored plasters may be purchased ready for use with the addition of water only. There are at least 12 standard shades of color as well as white. Manufacturers issue color cards, and take great care to ensure absolute uniformity in matching the shades to avoid *joining* marks.

Hard trowel finish, or Keene's cement, as it is known to the trade, is the densest and hardest gypsum finish that can be applied with a trowel. It hardens in about 2 hours. Because of its quick setting property, it is always used with lime putty to slow the set somewhat, and vary the finish. The proportion of 25 lbs. of lime putty to 100 lbs. of Keene's cement gives a hard trowel finish. Eighty pounds of lime putty produces a medium hard finish that the amateur plasterer will find easier to handle. Because it takes a hard glassy finish it is especially useful in bathrooms, kitchens, or other plastered spaces where water, cooking fumes or odors might discolor the walls or ceilings. It is easily cleaned without harming the original finish. One 100 lb. bag will cover about 25 sq. yds., one coat.

Mixing Plaster. *Scratch and Brown Coats.* Three coats of plaster are commonly applied: the first, or scratch coat; the second, or brown coat; and the third, a finishing coat. Store all plastering materials, including the

sand, in a dry place. Make a water-tight mixing box of clean boards or planks approximately 7′ long, 3′ wide, and 10″ deep. Raise one end about 4″, and use the lower end for mixing each batch. Mix just enough plaster for an hour's work because retempered materials lose strength with each partial set. Provide 2 separate containers for water: one for mixing, the other for washing tools. Do not rinse tools in the mixing water, because the dissolved plaster will cause the freshly mixed plaster to set much quicker than necessary. This will cause considerable inconvenience by making it

FIG. 5.26 Mixing plaster.

necessary to work faster, in order to get the plaster on the wall before the first set begins.

Cover the bottom of the box with sand, and then fill the box with alternate layers of sand and gypsum plaster, until it is full to the top. Mix the layers together thoroughly by cutting through with a hoe, at least twice, from one end to the other. Hoe the dry mix into a heap at the higher end of the box, leaving just enough for the first batch at the lower end.

Following this dry mixing, water should be added as required for the scratch coat. It will be found relatively easy to control the amount of water and prevent drowning the mix. The amount of sand cannot be determined exactly until one batch has been tried on the wall. Table 4 gives the standard proportions as follows:

Scratch Coat: 2 parts of sharp sand to 1 part of gypsum plaster.

Brown Coat: 3 parts of sand to 1 part of gypsum plaster.

These proportions are measured by weight.

If it is inconvenient to weigh the materials for the first batch, there is another method that can be used, although it is less accurate. A 1 : 2 mix for the scratch coat is roughly equal to 8 to 10 shovels of sand to a 100 lb. sack of prepared gypsum plaster, using a standard No. 2 shovel. The brown coat, 1 : 3 mix, can be proportioned by using 14 to 16 shovels of sand to a bag of plaster. The exact amount of sand must be determined by the *feel* of the plaster mix as it is used on the wall. If there is too much sand in the mix, the plaster will not stick well, and will show a definite tendency to fall out of place as it is pressed and smeared into position. This may be corrected by reducing the amount of sand in successive batches until the mortar holds quickly and easily with each stroke. On the other hand, too little sand results in a very sticky and hard working mix that slows up the work and requires much more effort to spread over the wall. It will be necessary, therefore, to experiment with the first few batches until just the right amount of sand has been determined by practice. All subsequent batches should be then mixed in the proportions so determined.

The strength and uniformity of plaster depends upon thorough dry mixing before adding the water. Uneven distribution of sand in plaster causes weak spots in the wall that cannot be corrected unless they are cut out and replastered.

Sanded plaster prepared by the manufacturer should be mixed by emptying a bag in the upper end of the mixing box, and hoeing it into the mixing water in the lower end. Mix just enough for immediate use. It should not be necessary to add any sand to make the plaster spread properly.

Estimating Quantities. Tables 1, 2, and 3 may be used to estimate the quantities of materials needed for the scratch and brown coats of plaster. The quantities vary considerably, according to the kind of lath over which the scratch coat is to be plastered. Metal lath requires over 50% more plaster for the scratch coat than wood lath. In every case, however, the brown coats require about the same quantities.

Although not stated in the text, these tables combine both scratch and brown coat quantities. As sand is added to the cement plaster in Table 1 only, the sanded proportions shown in parentheses refer to the first or scratch coat only. The second or brown coat would be sanded 3 : 1 as outlined in the text of this chapter.

Example: What quantities of gypsum plaster and sand will be required for the scratch and brown coats over wood lath for a room 12′ wide, 16′ long, and 9′ high? There are two windows 2′ 8″ × 5′ 6″ high and a door 3′ 0″ × 7′ 0″ high. Total thickness of lath and plaster is to be ⅞″.

$$\begin{array}{lll} 2(12 \times 9) & = 216 \text{ sq. ft.} & \text{Door} = 21. \text{ sq. ft.} \\ 2(16 \times 9) & = 288 \text{ sq. ft.} & \text{Windows} = \underline{29.26} \text{ sq. ft.} \\ 12 \times 16 & = \underline{192} & \quad 50.26 \text{ sq. ft.} \\ & \quad 696 & \\ & \underline{-\ 50.26} & \\ & \quad 645.74 \text{ sq. ft.} = 71.75 \text{ sq. yds. surface} & \end{array}$$

Scratch coat 1 : 2
Brown coat 1 : 3
2 : 5 proportions

2 bags cement plaster + 500 lbs. (5 cu. ft.) sand = 18 to 21 sq. yds. plaster; therefore 71.75 yards of plaster + 5% for waste = 75.25 sq. yds. of plastering materials required, or:

8 bags of cement plaster (800 lbs.)
2000 pounds of sand (20 cu. ft. or ¾ yd.)

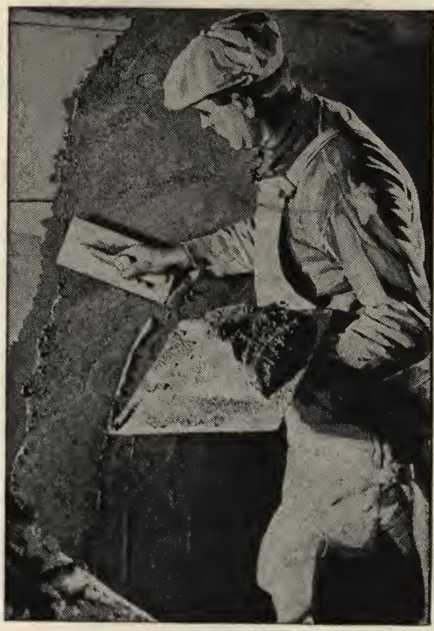


FIG. 5.27. Applying scratch coat on plaster base.

Applying Plaster. Good plastering requires the proper application of each of the three separate coats, with each bonded closely to the other so that they form a solid shell. The first or "scratch" coat should be applied to the lath with firm sweeping strokes as shown in Figs. 5.27, 5.28, 5.29. The

FIG. 5.28. Applying scratch coat on paper backed wire lath.

FIG. 5.29. Applying scratch coat on ceiling of room.

mortar should be pressed into the openings in the lath so that some plaster will be forced through the spaces, and form a good key behind the lath. In the case of the rigid insulating lath, it is necessary to produce suction between the plaster and the lath surface. In any event, the first coat must become so firmly anchored to the lath that ordinary vibration will not cause separation. The first coat always requires about 50% more plaster than the second coat.

FIG. 5.30. Using straightedge against the grounds to smooth and straighten brown coat.

The second or brown coat may be sanded more than the scratch coat although many plasterers use the same mix for both. If sanded, the proportions should be 1 part of gypsum cement to 3 parts of sand. This coat must be applied so as to form a straight, level, and smooth coat with an even surface. Use the grounds, corner beads or other guides to bring this coat of plaster out to the desired plane. The finish coat is so thin that in most cases it may be disregarded in computing plaster thickness. Figure 5.30 shows how the straightedge is used against the grounds to smooth and straighten the brown coat. Another tool called a *darby* is used to level any slight mounds or hollows.

Keep plaster from freezing for 24 hours after application. In hot, dry weather screen all openings with muslin while plastering, to prevent material from drying out before it has set. If plaster should dry out, showing soft, white spots or areas sprinkle the dry places with clean water. After plaster has set, open windows and permit wall to dry as quickly as possible.

Table 1

Basis — Under average conditions Gypsum Cement Plaster mixed and applied in accordance with standard specifications will cover about as follows:

Plastering Surface	Wood Lath	Metal Lath	Gypsum Lath	Brick and Clay Tile	Gypsum Tile
Sq. yds. per ton 20 bags	180–210 (Sanded 2 : 1)	105–135 (Sanded 2 : 1)	225–240 (Sanded 2 : 1)	165–200 (Sanded 3 : 1)	235–255 (Sanded 3 : 1)

Table 2

Basis — Under average conditions Gypsum Fibered Plaster mixed and applied as specified will cover about as follows:

Plastering Surface	Wood Lath	Metal Lath	Gypsum Lath
Sq. yds. per ton 2000 lbs.	90–100 (Unsanded — water only added)	55–65 (Unsanded — water only added)	115–120 (Unsanded — water only added)

Table 3

Basis — Under average conditions Gypsum Prepared Plaster mixed and applied in accordance with standard specifications will cover about as follows:

Plastering Surface	Wood Lath	Metal Lath	Gypsum Lath	Brick and Clay Tile	Gypsum Tile
Sq. yds. per ton 20 bags	60 : 70	35 : 45	75 : 80	45 : 55	65 : 70
	(Plaster mixed with water only — no sand added)				

Table 4 gives a résume of various points to be observed in lathing and plastering. Note that wood lath *must* be wet when plastered. All other lath are kept dry.

TABLE 4

WOOD LATH	GYPSUM LATH	WIRE LATH	METAL LATH	INSULATING LATH	MASONRY WALLS
Use No. 1 white pine, cypress, or spruce, free from knots, sap, and bark; lath to be spaced not more than 3/8" nor less than 1/4" apart. To avoid long, straight, vertical joints, not more than 7 laths shall be laid up directly over each other. Two nails at ends of lath and 1 at supports. Lath shall be soaked before plaster is applied.	Lath shall be not less than 3/8" thick. Boards shall be staggered to avoid continuous vertical joints at all points. Nail 4" apart at each support. Do not wet lath. Use metal reinforcing at all joints, angles, and around all door and window openings.	Nail every 6" at supports or equivalent with clips. Lath shall be staggered to avoid continuous vertical joints at all points. Lath shall be bent around all interior and exterior angles and lapped at all joints.	Nail every 6" at supports or equivalent with clips. Lath shall be staggered to avoid continuous vertical joints at all points. Lath shall be bent around all interior and exterior angles and lapped at all joints.	Lath shall be not less than 1/2" thick. Boards shall be staggered to avoid continuous vertical joints at all points. Nail 5 1/2" apart at each support. Use metal reinforcing at all joints, angles, and around all door and window openings.	Use gypsum or cement plaster on terra-cotta tile or brick walls. Wet walls before applying the plaster. Use gypsum plaster on gypsum block walls and do not wet walls before applying plaster. Use cement plaster on concrete walls and wet walls before applying plaster.
Thickness, including lath and plaster, from face of supports to finished plaster:					
7/8"	7/8"	3/4"	3/4"	1"	5/8"

Plaster shall be applied in 3 coats: scratch, brown, and finish coats.
All areas shall be plastered uniformly to the required thickness.
Plaster shall be kept from freezing 24 hours after application. In hot, dry weather all openings shall be screened to prevent drying out before plaster has set.
Scratch coat shall be of 2 parts of sand to 1 part of plaster, by weight.
Brown coat shall be of 3 parts of sand to 1 part of plaster, by weight.

Mixing the Finish Coat. If prepared gypsum finish is used, proceed in the following way. Put the finish in the upper end of mixing box, and the water in lower end. Hoe plaster into water, using 1 part water to 2 parts plaster, measured by volume. Allow material to soak and draw in the water, without hoeing for at least half an hour. When material has soaked and shows no further signs of air bubbles, mix thoroughly and with particular care break down the mix to a smooth, even, creamy consistency. Bring the mix finally to a very thin consistency. Transport in buckets.

When finishing with lime and gauging plaster, the first operation is the preparation of lime putty. To prepare putty from hydrated lime, fill a water-tight box about half full of clean water. Add dry hydrated lime slowly, sifting through a ¼″ mesh screen, until all the water is dried up. Allow lime to soak overnight to develop its full plasticity. Do not hoe or screen after soaking, unless lime is dirty or lumpy. Then the finish coat is prepared by mixing 1 part of gauging plaster with 3 parts of lime putty, as follows: for each 12 quart bucket, approximately 37 lbs., of lime putty, 2 quarts of clean water are added. Enough dry plaster is sifted into the mix to absorb the water. The plaster and lime putty are then blended together thoroughly. The above proportions equal 1 part of dry gauging plaster to 2 parts by weight of dry hydrated lime.

Applying the Finish Coat. Finish or white coats are generally applied, or *skimmed* on, in 2 or 3 very thin coats, one after the other, until the surface is 1⁄16″ to ⅛″ in thickness. The brown coat must be hard and dry before this work begins, because cracks or soft spots are likely to develop if the under coat is damp when the finish is troweled on. A simple putty coat needs more sand for finishing than a hard finish. The latter must be gauged with plaster of Paris mixed with the putty on the mortar board just before it is skimmed on the walls.

It should be unnecessary to trowel out low or high spots in the finish coat of plaster, if the under coats were prepared carefully. The steel trowel is used in the same manner as for the brown and scratch coats, but it will be found that the white coat spreads rapidly and very easily over the surface of the brown coat. Thus the 2 or 3 finish coats may be applied one after the other as fast as each sets enough to skim over it without wrinkling the surface. The surface should be finished with wide sweeping strokes to eliminate waves, ripples, or slight edge marks, until it appears to have made the initial set.

After troweling, the whole surface should be gone over again with a clean hair brush and steel trowel. The brush is wet with clean water and moved

ahead of the trowel in smooth, quick strokes. The finish plaster may be thus wet-brushed, and buffed or polished until a glossy surface is obtained. Do not drench with water because this will kill the face of the wall. The work should continue until the entire area is finished. Most plasterers do the top and bottom sections first and finish the spaces between last so that the most time and effort may be given to that part of the surface at eye level.

Proper drying conditions must be maintained until the finished wall is completely dried out. During the late fall, winter, and early spring there is danger of sudden frosts or freezing. Enough heat and ventilation must be provided, usually for a week, to protect the work during this period.

Plastering Troubles. The following are the common job conditions that adversely affect gypsum plaster. In most cases they are the result of carelessness and can be avoided easily.

Dry-outs, usually caused by hot, dry weather, occur wnen the plaster dries before it sets. When this condition occurs, soft, chalky areas appear. It may be corrected by spraying the area affected with water, and keeping the wall damp until the plaster sets. This will not harm the wall.

Dry-outs may be eliminated very quickly by wetting the surface with a solution made by dissolving 6 oz. of zinc sulphate or alum in 12 qts. of water. Wet the area evenly with this solution, and then dampen thoroughly with water.

Sweat-outs are the reverse of dry-outs, and occur most frequently in cold weather. In this case the plaster sets before the water has had time to evaporate. Damp, musty, and dark walls are a sure indication of this condition. Free circulation of air and the use of heat in very cold weather to prevent freezing will correct this situation with no loss in plaster strength.

Slow setting is usually caused by dirty sand or water. Weather conditions play such an important part in the drying and setting of plaster that it is impossible to give any exact time for plaster setting. However 6 to 8 hours should be ample time for a firm condition of the coat to be evident.

There are several methods of accelerating the setting of plaster without any injurious effect. One is to add plaster droppings, crushed and screened, or hydrated lime, or Portland cement in the ratio of 1 qt. of this added material to each sack of plaster. About 15 lbs. of plaster of Paris to a barrel of water accelerates the set. The water should be stirred thoroughly as added.

Quick setting may be caused by a number of conditions, but carelessness in selecting or mixing the ingredients on the job is the chief cause. Mixing with water in which tools have been washed, the presence of set plaster in

the mix, and mixing more material than can be used in an hour are the most common errors.

Pops and *blisters* in lime putty finishes are caused by the lime being insufficiently slaked before application. These are called *butterflies*. In order to be absolutely sure that pops and blisters will not occur, common lime should be slaked several weeks before it is used. This gives the mass time to blend and work out completely. A better insurance against these defects is the use of hydrated lime. None of the finishes should be laid on in a single coat. The best trade practice to obtain the maximum bond between the base coat and the finish coat is first to *grind in* a thin application of the finish coat. The next skim coat is troweled to the desired finish.

Other causes of plaster failure that cannot be blamed on the materials or the workmanship are:

Perceptible movement of large structural timbers, caused by settlement, shrinkage, faulty nailing, etc.

Uneven settlement of foundations, because of improper footings, soft earth, poor workmanship, or materials, etc.

Chimney movement, resulting from faulty construction of the chimney. In a frame house, all plaster must stand free and clear of the chimney. Resting beams upon the chimney will surely result in plaster trouble.

Skimped or cheap construction, by the use of structural members that are inadequate in size or quality for the loads imposed upon them.

Chapter 3

STUCCO

Preparation of Surfaces: Masonry, Acid Wash . . . Metal Reinforcement . . . Flashing . . . Preparation for Stucco . . . Portland Cement Stucco . . . Factory-mixed Stucco . . . Colored Stucco . . . Tools . . . Mixing and Applying Stucco . . . Various Coats . . . Textures

Stucco is a finishing material that is applied to the outside of a building for protection from weather and, to a limited extent, from fire, as well as for insulation and improved appearance. Stucco consists of a cementing agent such as Portland cement or gypsum, hydrated lime, sand, and water. The use of the lime is optional; it makes the mixture *fatter* and hence easier to apply. Coloring materials may also be added but they are difficult to mix properly, and for this reason the reader is urged, if he plans to use colored stucco, to buy the ready-mixed variety, and not to attempt to color his own materials. Plain white stucco, however, can be mixed easily on the job by methods to be explained later in this section.

Stucco is essentially a skin of mortar held in position by some reinforcement, or simply by the bond formed with the material underneath. It can be applied over almost any plane surface. Masonry with a rough textured surface provides an excellent stucco base. If all the joints are raked out slightly, they form additional keys to hold the stucco in place.

A building finished with stucco is warmer in winter and cooler in summer, because of the insulating properties of the porous skin of stucco.

Preparation of Wall Surface for Stucco. There are two general types of wall surfaces to which stucco is applied; masonry, to which the stucco is bonded so that it becomes an integral part of the wall when it sets (Fig. 5.31), and structural surface to which the stucco is anchored in the form of a thin reinforced concrete shell (Fig. 5.32). Stucco reinforced with metal or wire lath over a frame structure, is an example of this latter type of construction.

Walls of concrete, hollow tile, concrete blocks, or common brick are excellent bases for the direct application of stucco. The surfaces of these walls must be rough, clean, and free from paint or dirt that might interfere with the bonding action. Old masonry walls, disintegrated by the action of weather, salt air, or chemical fumes require a covering of metal

reinforcement before the application of stucco. New stucco cannot be applied over cracked or bulging old stucco walls. A clean, firm, and absorbent surface is absolutely essential for durability.

The *preparation of masonry surfaces* for stucco is done according to the following methods. Old concrete walls should be roughened with a bush hammer or a small pick, and then washed thoroughly with acid and water

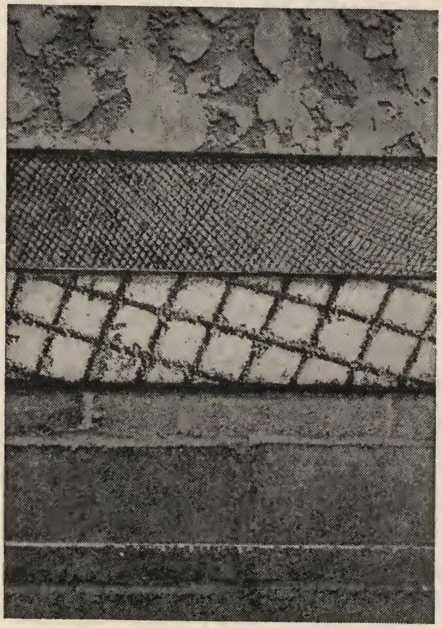


Fig. 5.31. Portland Cement Stucco on concrete masonry. Stucco and masonry bond perfectly, because each is made of the same basic material — Portland cement. Each coat must be given two days for damp curing and then allowed to dry.

to remove all dirt and loose particles. This ensures good bonding. New concrete can be roughened with a heavy wire brush or a special scoring tool just after the forms have been removed. The forms for this concrete should not be oiled, or coated with any material that is likely to remain on the surface of the concrete and thus prevent a perfect bond between stucco and concrete. There are special compounds available which produce a pitted surface when painted on the concrete forms. The desired roughness is secured by brushing off this special material after the forms are removed.

New or old brickwork must be hammered or chipped to pit its surface. The removal of the mortar joints to a depth of about ½″, where this can be accomplished without too much labor, produces an excellent and lasting key. Painted brickwork must be chipped and washed with acid until all paint is removed. Stucco will not bond with the oily surface of paint. Walls of brownstone, limestone, fieldstone, etc., must be roughened with a bush hammer or pick to obtain a clean, rough surface.

Most cement block and hollow tile walls are sufficiently rough and clean to receive stucco without additional treatment. In anv event, an acid wash will ensure an excellent surface.

Acid Wash. It is customary to use a strong acid to clean masonry surfaces. This operation removes all dirt, grease, or particles of mortar. Concentrated hydrochloric acid (also called muriatic acid) is diluted with water. Wooden buckets must be used. This solution will attack and destroy even the masonry surface if allowed to remain on it for more than a few minutes. A solution of 1 part of muriatic acid to 6 parts of water is excellent for cleaning new concrete, or very dirty, old walls covered with paint, soot, or grime. Old concrete, or fairly clean masonry walls may be washed with a solution of 1 part of acid to 10 parts of water.

The following procedure should be followed carefully to obtain good results. First wet the wall surface with clean water so that the acid may act upon the surface only. Using a stiff fiber brush (hair or bristle brushes will be destroyed by the acid), and a rubber glove to keep the hand out of the acid, scrub the surface quickly and thoroughly with the acid solution. Immediately after the acid treatment and before it has time to dry into the wall, wash with clean water until all traces of the acid have been removed. If the first treatment does not clean the surface, alternate treatments of acid solution and water should be applied.

Metal Reinforcement. When stucco cannot become an integral part of the wall as in the case of masonry covered with stucco, it is necessary to *hang* and maintain the shell by means of metal reinforcing that serves two purposes. First, it holds the coat of stucco against the plane surface, and second, it reinforces the stucco itself. Wood or steel frame structures of the open or sheathed type, disintegrated masonry surfaces, and old stucco which is to be refinished require the use of reinforcement. Furthermore, metal reinforcement must be applied wherever stucco is to be carried over metal flashing. This is especially important over doors, windows, dormers, etc.

Before beginning the metal lathing, the entire structure should be in-

spected carefully. This is the best time to replace rotted or damaged siding, trim, frames, gutters, flashings, etc. On new work, careful attention should be given to corner bracing, well-secured sheathing, and all other structural members that are to carry the finished stucco shell. It is much more costly, as well as dangerous to the finish, to attempt to do alterations or to

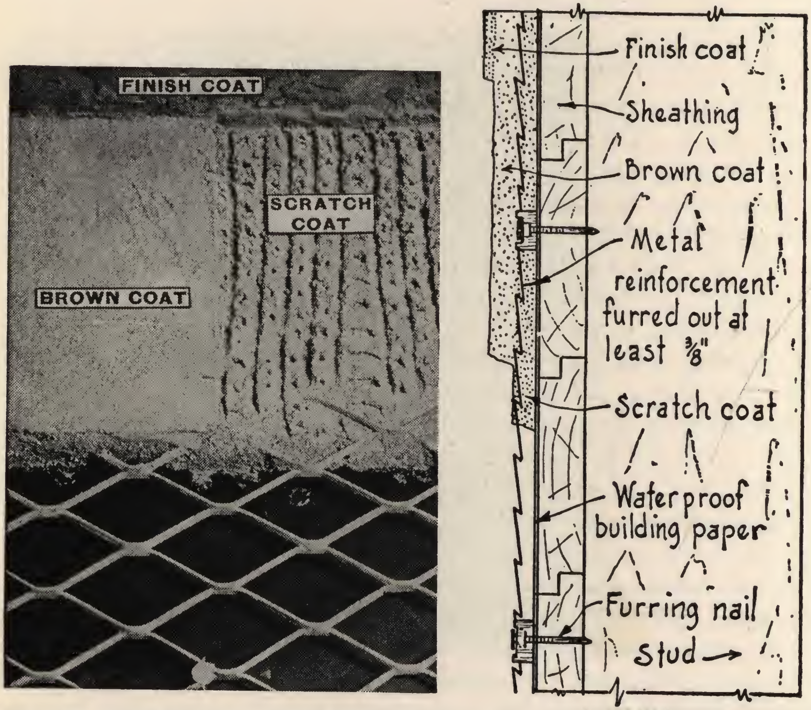


Fig. 5.32. Showing proper construction for stucco on metal reinforcement. Note the backing of waterproof building paper, the metal reinforcement held at least ¼ in. away from the backing with furring nails, and the scratch coat filled in solidly behind the metal.

make final installations *after* the stucco has been applied. A good, tight, and well-braced frame is the best insurance against stucco failure.

Waterproof Paper. All surfaces that are to receive open metal reinforcement, except areas to be back plastered, should first be covered with waterproof building paper as shown in Fig. 5.32. There are many types, grades, and weights of paper available. It is useless to use a very light paper that will tear or disintegrate quickly. Twenty pound felt (so called because 100

sq. ft. weighs 20 lbs.) is excellent. There are other papers containing a sisal or hemp mixture that is exceedingly tough and water-resistant. The paper is fastened to the structure with special, large headed, galvanized nails. Resin paper is not waterproof, and should never be used.

The paper has two functions to perform. First it acts as an insulating medium against wind, moisture, and the natural dampness of the stucco

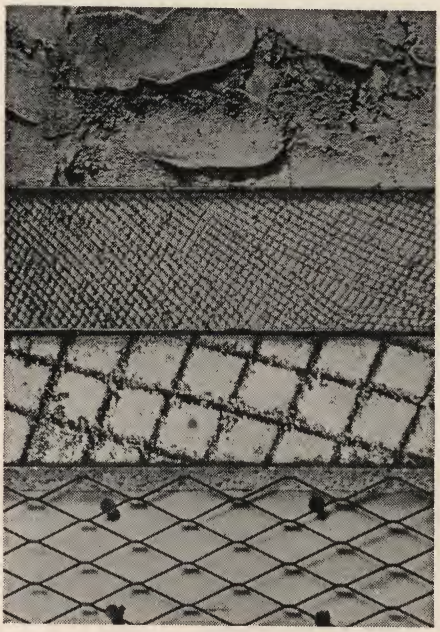


FIG. 5.33. Portland Cement Stucco on frame construction. Each coat of stucco should be heavily scored to provide a good bonding surface for the succeeding coat. No coat should be applied until the preceding one has thoroughly cured.

itself. Second, it acts as a blotter to absorb all moisture that penetrates the stucco shell as long as the stucco remains in place. This is the most important part that the backing paper plays. A light, loosely applied, or poorly manufactured paper that dries out quickly will permit moisture penetration after a very few years on the wall. The consequent dampness will cause serious deterioration of a wood structure and start cracks in the stucco that are difficult to repair.

Applying Paper Backing. Most manufacturers include the proper nails

with every roll of building felt or paper. These nails should be used, as they are specially designed for this purpose. Galvanized nails will resist rust, although needle pointed, copper nails are available at a slight extra cost. Just before starting this work, inspect the surfaces to be covered, and eliminate all protruding nail heads, splinters, cracks, etc., that might tear the paper. Lath may be tacked across the paper as it is first stretched over the structure, to hold it in place until the permanent fastenings are made.

Beginning at the bottom of the wall, the rolls of paper should be nailed in place. As upper strips should overlap lower strips by about 3″, it is good practice to tack both strips in place with the laths temporarily, before nailing. The vertical joints should be lapped at least 6″. It is considered good practice to double the paper at all corners or sharp breaks. It is especially important to tuck and fit neatly around door and window casings or other points where wood and stucco meet. The use of mastic cement to seal all joints is an added protection against wind and moisture penetration.

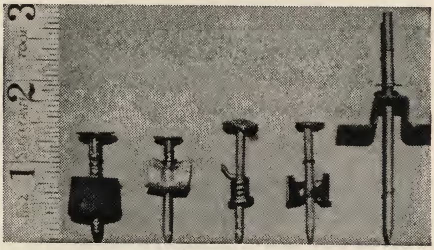


Fig. 5.34. **Several types of furring nails — to accommodate practically any of the types of metal reinforcement available.**

Applying the Metal Reinforcement. Large mesh, expanded metal, or wire lath, weighing 1.8 or 3.6 lbs. per sq. yd., is absolutely essential. Many amateurs and speculative builders make a very serious mistake in using the small, diamond mesh plaster lath that is intended for interior plaster only. This lath is worse than useless outside, because it will rust out completely in a very short time. Do not use it for stucco. There are several types and sizes of copper bearing or galvanized steel, as well as plain or paper backed mesh with special reinforcing angles. In every case the weight per square yard is given as well as the size of wire, type of steel, etc., to assist in the selection of the proper mesh for the particular job.

The metal lath must be secured firmly in position. Special furring nails (Fig. 5.34) are provided that space the lath out from the wall so that the

stucco can be forced behind and around the reinforcing until it is embedded completely. The five types shown are suitable for almost every job. In general the furring nails and washers hold the mesh about $\frac{3}{8}''$ clear of the wall.

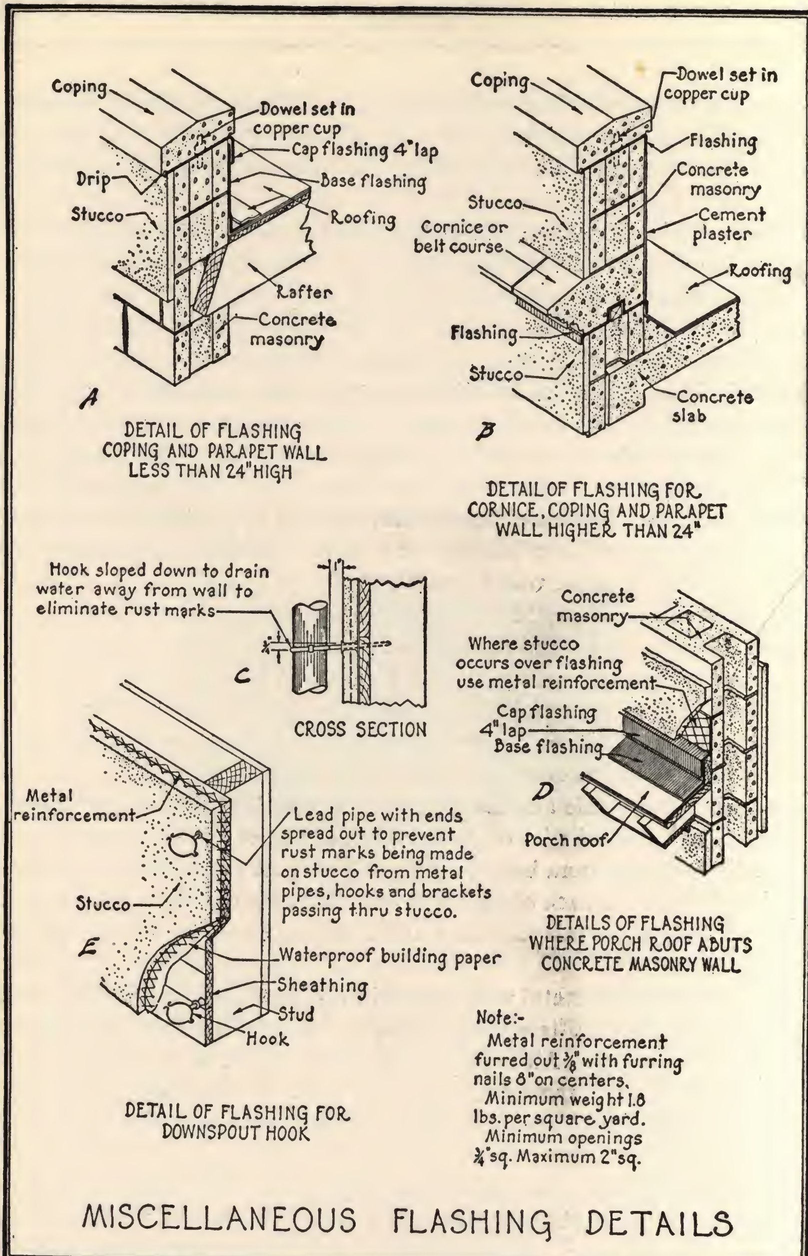
The reinforcement must form a continuous network of metal over all the surfaces to be covered. All laps should be at least one mesh wide, wired firmly together. All corners should occur near the middle of a sheet of lath. Never join two sheets at a corner because weakness will develop.

Flashing. All flashing must be made of copper or lead covered copper (Figs. 5.35 to 5.38). The latter will not turn green and discolor the finish. The essential purpose of all flashing is the prevention of water seepage behind the stucco. It is obvious that all projections present surfaces, on and under which water may collect and run back behind the stucco. For this reason all sills, door heads, cornices, copings, belt course, etc., must be flashed and counter-flashed, *under* the metal reinforcing. Such places as a water table, or the point where a porch or terrace joins the house, should be waterproofed carefully. It is considered very poor construction to run stucco down to the ground line, or to any other place where snow, soil, or any other moisture bearing material can attack it. Figures 5.35 to 5.38 show how to flash some of the most important points in the building.

Preparation for Stucco. In new construction, the foundation should have a 4″ shelf on which a course of brick may be built. This makes a neat and permanent water table and base for the stucco. The sills of the building should be well slushed with cement mortar, or pargeted with mastic cement to seal all openings from below. This will prevent moisture from working up to the sills or the back of the studs by capillary attraction. This is good construction, and a safeguard for the interior plaster as well as for the stucco.

In general all sheet metal work should be completed *before* the stucco work begins. New or old gutters should be hung, and the downspouts and leaders cut ready for fitting. All hangers and hooks should be installed so that water will drain from them away from the wall. Do not place hooks level or tilted upward, as water will collect at the wall and stain or work through the stucco in a very short time.

Every stucco job requires some carpentry work. New sub-sills, window and door frames, baseboards, etc., must be set in place, back-painted or sealed with mastic, etc., before any other work is started. Some builders use metal corner beads to ensure straight and true corners. If these are used they *must* be of the moisture resisting type, because the corners of any build-



Coping
Dowel set in copper cup
Cap flashing 4" lap
Drip
Base flashing
Stucco
Roofing
Rafter
Concrete masonry
A
DETAIL OF FLASHING COPING AND PARAPET WALL LESS THAN 24" HIGH
Coping
Dowel set in copper cup
Flashing
Concrete masonry
Stucco
Cement plaster
Cornice or belt course
Roofing
Flashing
Stucco
Concrete slab
B
DETAIL OF FLASHING FOR CORNICE, COPING AND PARAPET WALL HIGHER THAN 24"
Hook sloped down to drain water away from wall to eliminate rust marks
1"
C
CROSS SECTION
Concrete masonry
Where stucco occurs over flashing use metal reinforcement
Cap flashing 4" lap
Base flashing
D
Porch roof
DETAILS OF FLASHING WHERE PORCH ROOF ABUTS CONCRETE MASONRY WALL
Metal reinforcement
Lead pipe with ends spread out to prevent rust marks being made on stucco from metal pipes, hooks and brackets passing thru stucco.
Stucco
E
Waterproof building paper
Sheathing
Stud
Hook
DETAIL OF FLASHING FOR DOWNSPOUT HOOK
Note:-
Metal reinforcement furred out 3/8" with furring nails 8" on centers.
Minimum weight 1.8 lbs. per square yard.
Minimum openings 3/4" sq. Maximum 2" sq.
MISCELLANEOUS FLASHING DETAILS

FIG. 5.35.

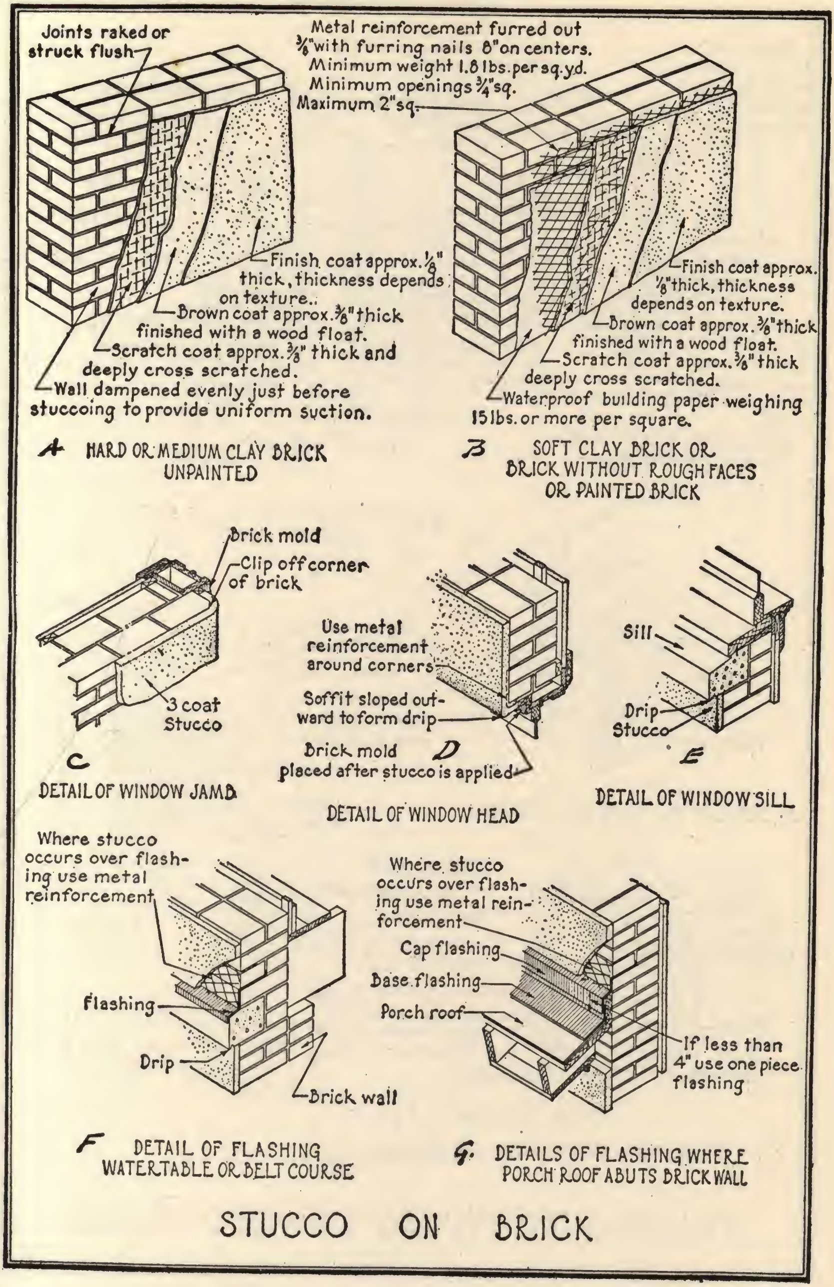

Joints raked or struck flush
Metal reinforcement furred out 3/8" with furring nails 8" on centers. Minimum weight 1.8 lbs. per sq. yd. Minimum openings 3/4" sq. Maximum 2" sq.
Finish coat approx. 1/8" thick, thickness depends on texture.
Brown coat approx. 3/8" thick finished with a wood float.
Scratch coat approx. 3/8" thick and deeply cross scratched.
Wall dampened evenly just before stuccoing to provide uniform suction.
A HARD OR MEDIUM CLAY BRICK UNPAINTED
Finish coat approx. 1/8" thick, thickness depends on texture.
Brown coat approx. 3/8" thick finished with a wood float.
Scratch coat approx. 3/8" thick deeply cross scratched.
Waterproof building paper weighing 15 lbs. or more per square.
B SOFT CLAY BRICK OR BRICK WITHOUT ROUGH FACES OR PAINTED BRICK
Brick mold
Clip off corner of brick
3 coat Stucco
C DETAIL OF WINDOW JAMB
Use metal reinforcement around corners
Soffit sloped outward to form drip
Brick mold placed after stucco is applied
D DETAIL OF WINDOW HEAD
Sill
Drip
Stucco
E DETAIL OF WINDOW SILL
Where stucco occurs over flashing use metal reinforcement
Flashing
Drip
Brick wall
F DETAIL OF FLASHING WATERTABLE OR BELT COURSE
Where stucco occurs over flashing use metal reinforcement
Cap flashing
Base flashing
Porch roof
If less than 4" use one piece flashing
G. DETAILS OF FLASHING WHERE PORCH ROOF ABUTS BRICK WALL
STUCCO ON BRICK

Fig. 5.36.

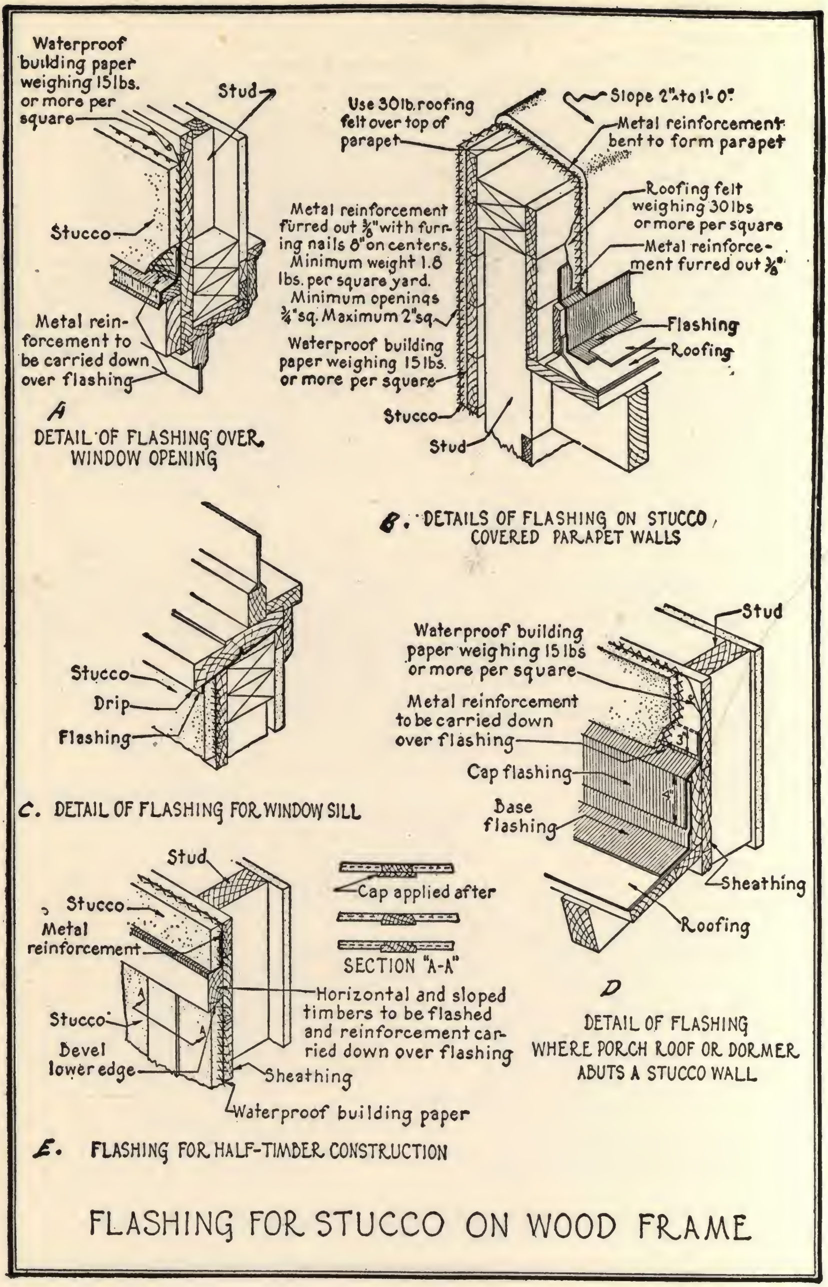

Waterproof building paper weighing 15 lbs. or more per square
Stud
Stucco
Metal reinforcement to be carried down over flashing
A
DETAIL OF FLASHING OVER WINDOW OPENING
Use 30 lb. roofing felt over top of parapet
Slope 2" to 1'-0"
Metal reinforcement bent to form parapet
Roofing felt weighing 30 lbs or more per square
Metal reinforcement furred out 3/8"
Metal reinforcement furred out 3/8" with furring nails 8" on centers. Minimum weight 1.8 lbs. per square yard. Minimum openings 3/4" sq. Maximum 2" sq.
Waterproof building paper weighing 15 lbs. or more per square
Flashing
Roofing
Stucco
Stud
B. DETAILS OF FLASHING ON STUCCO COVERED PARAPET WALLS
Stucco
Drip
Flashing
C. DETAIL OF FLASHING FOR WINDOW SILL
Stud
Waterproof building paper weighing 15 lbs or more per square
Metal reinforcement to be carried down over flashing
Cap flashing
Base flashing
Sheathing
Roofing
D
DETAIL OF FLASHING WHERE PORCH ROOF OR DORMER ABUTS A STUCCO WALL
Stud
Stucco
Metal reinforcement
Stucco
Bevel lower edge
Cap applied after
SECTION "A-A"
Horizontal and sloped timbers to be flashed and reinforcement carried down over flashing
Sheathing
Waterproof building paper
E. FLASHING FOR HALF-TIMBER CONSTRUCTION
FLASHING FOR STUCCO ON WOOD FRAME

Fig. 5.37.

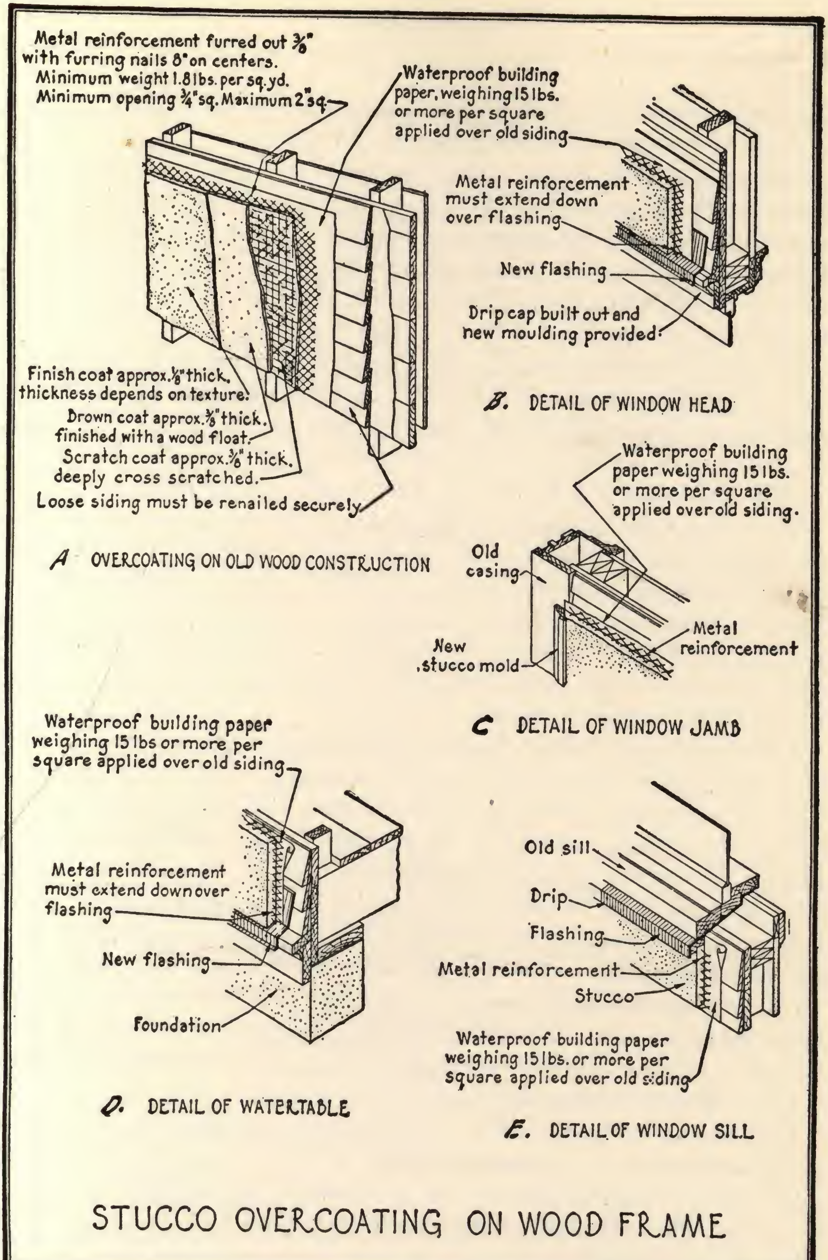

Metal reinforcement furred out 3/8" with furring nails 8" on centers.
Minimum weight 1.8 lbs. per sq. yd.
Minimum opening 3/4" sq. Maximum 2" sq.
Waterproof building paper, weighing 15 lbs. or more per square applied over old siding
Finish coat approx. 1/8" thick, thickness depends on texture.
Brown coat approx. 3/8" thick, finished with a wood float.
Scratch coat approx. 3/8" thick, deeply cross scratched.
Loose siding must be renailed securely
A OVERCOATING ON OLD WOOD CONSTRUCTION
Metal reinforcement must extend down over flashing
New flashing
Drip cap built out and new moulding provided
B. DETAIL OF WINDOW HEAD
Waterproof building paper weighing 15 lbs. or more per square applied over old siding.
Old casing
New stucco mold
Metal reinforcement
C DETAIL OF WINDOW JAMB
Waterproof building paper weighing 15 lbs or more per square applied over old siding
Metal reinforcement must extend down over flashing
New flashing
Foundation
D. DETAIL OF WATERTABLE
Old sill
Drip
Flashing
Metal reinforcement
Stucco
Waterproof building paper weighing 15 lbs. or more per square applied over old siding
E. DETAIL OF WINDOW SILL
STUCCO OVERCOATING ON WOOD FRAME

FIG. 5.38.

ing are the weakest part of the structure. A crack or failure at these points is a sure indication of poor workmanship or materials.

Portland Cement Stucco. Common Portland cement of any standard brand meets the requirements for a good cementing agent in stucco. However, when a nonstaining white stucco is required, a special cement known to the trade as LaFarge white cement is recommended. This cement will not discolor limestone or marble, but Portland cement will cause ugly stains that cannot be removed.

The fine aggregate should be clean sand, preferably screened into two different grades, coarse and fine. The coarse sand should be used in the base and scratch coats, while the finer grade is reserved for the finish coat. All sand should be free from loam, silt, and vegetable matter.

Only water that is fit to drink should be used in mixing stucco.

It is necessary to add some material to make the stucco mix work easily and smoothly as it is being applied to the wall. Hydrated lime, very fine clay, or asbestos fiber are common plasticity agents. They produce a *buttery* consistency in the moist stucco that enables the workman to spread it with greater ease. These materials should not be added in excess of the amounts given in this Section because excessive amounts reduce strength and increase porosity of stucco.

Patent or Factory Mixed Stucco. To eliminate entirely the possibility of error in proportioning or mixing stucco materials, several manufacturers offer factory mixed stucco guaranteed to meet definite standards. These ready-mixed stuccos are sold in 100 lb. paper sacks. All ingredients, including the correct proportion of sand, are present, ready to be mixed. Only water needs to be added. It is best for the average amateur to use these prepared stuccos because all the problems of correct proportion, color, and good materials have been eliminated by the factory.

Colored stucco may be produced by adding color to each batch as it is mixed on the job, or by using factory mixed and prepared stucco. The latter is by far the surest way to secure the correct color in uniform batches that will not show streaks or edges when spread on the wall.

Coloring the finish coat of stucco presents more problems than appear to the casual observer. It is useless to apply a thin coat of color because the action of the weather together with a chemical reaction with the cement tends to produce unpleasant streaks or blotches. Aniline base colors and other organic or vegetable dyes are cheap and easy to obtain, but they will streak badly and fade as they weather. The best and only permanent pigments are the high grade minerals. These natural colors cannot fade or

streak, and require much less pigment than the vegetable colors to produce the same shade of a color.

Table 1 gives the relative proportions of color necessary to produce two different shades of color. This list is not complete because almost any color can be introduced by simply using a mineral that has been ground to a fine powder. The colors given are those in most common use with the exception of pure white.

Ready-mixed, colored stucco offers the most convenient way to obtain uniform results with practically no risk of failure. As all the work except the actual mortar mixing is done under factory controlled conditions, the purchaser need only consult a color card and order accordingly. This stucco is sold in 100 lb. paper sacks.

TABLE 1. COLORS FOR PORTLAND CEMENT STUCCO

Desired Color	Pigment	Pounds per bag of cement	
		Light shade	Medium shade
Black, Blue-black and Grays	Germantown Lampblack	½	1
	Carbon Black	½	1
	Black Oxide of Manganese	1	2
Blue	Ultramarine Blue	5	9
Brownish Red to Dull Brick Red	Red Oxide of Iron	5	9
Bright Red to Vermilion	Mineral Turkey Red	5	9
Brown to Reddish Brown	Metallic Brown (oxide)	5	9
Buff, Colonial Tint	Yellow Ochre with not less than 15% Yellow Oxide	5	9
Cream	Small Quantity of Yellow Oxide of Iron		
Green	Chromium Oxide	5	9
	Greenish-blue Ultramarine	6	
Pink	Red Oxide of Iron	4	8

Tools. In addition to the plasterer's tools mentioned in the Section on Plastering, a variety of special tools is shown in Figs. 5.39 to 5.50. These are used to produce special effects as noted under each illustration. A hammer and a pair of sturdy tin snips to cut and fasten the reinforcing mesh in place

FIG. 5.39. Standard Plastering trowel. Smaller size used for texturing. *Courtesy Portland Cement Assn.*

FIG. 5.40. Small leaf tool used for fine pointing. *Courtesy Portland Cement Assn.*

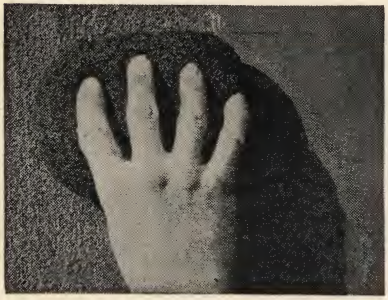


FIG. 5.41. A rubber sponge produces a pleasing surface. *Courtesy Portland Cement Assn.*

FIG. 5.42. Sheepskin glove used to rub down heavy textures. *Courtesy Portland Cement Assn.*

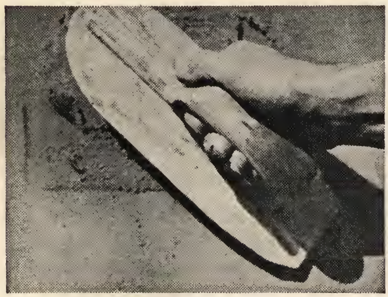


FIG. 5.43. A round point trowel. *Courtesy Portland Cement Assn.*

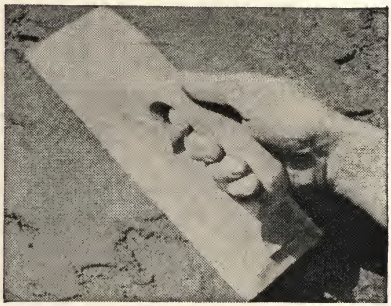


FIG. 5.44. Wood float. Covered with carpet to produce sanded finish. *Courtesy Portland Cement Assn.*

FIG. 5.45. Rubber glove used in making hand or palm textures. *Courtesy Portland Cement Assn.*

FIG. 5.46. A cork float. *Courtesy Portland Cement Assn.*

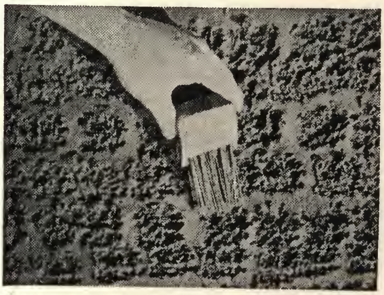


FIG. 5.47. The wire brush used in making the " Travertine " texture. *Courtesy Portland Cement Assn.*

FIG. 5.48. The Dutch brush used for applying washes or for softening rough textures. *Courtesy Portland Cement Assn.*

FIG. 5.49. The jointing tool for marking of surfaces to resemble masonry. *Courtesy Portland Cement Assn.*

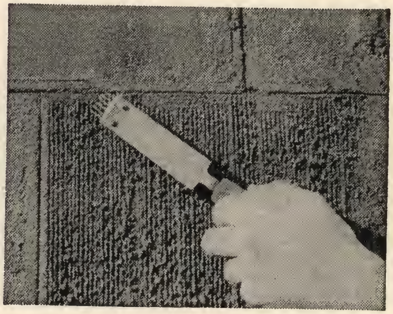


FIG. 5.50. Combing tool for producing the effect of a tooled stone finish. *Courtesy Portland Cement Assn.*

should be sufficient for the average job. The tools and equipment for the carpentry work around doors and windows are discussed in the Woodworking Section of this book. The reader should do this work carefully, so that all openings will be prepared properly for stucco.

Mixing Stucco. The best stucco work consists of three separate coats applied in succession, allowing sufficient time for each to cure or harden. The common, two-coat job is used only on the cheapest work and is never as satisfactory as three coats.

The scratch and brown coats (Fig. 5.32) are both mixed in the same proportions of 1 part of Portland cement to 3 parts of sand. The addition of 10 lbs. of hydrated lime per sack of cement makes the mix work easier. Materials are measured by volume. One sack of cement is 1 cu. ft. and weighs 96 lbs.

It is most important that all batches be measured and proportioned exactly alike. Materials should be mixed to a uniform color before the water is added. Hand mixing is satisfactory if it is done thoroughly, but machine mixing is much better. Only enough material should be mixed in each batch to keep the workmen busy. Any mix tends to separate and lose strength if it is permitted to stand for hours in the mixing box. Successive drying and wetting cause a serious loss in suction and setting.

The finish coat is proportioned, mixed, and colored to create the desired appearance. The finish coat may be made a little richer than the other coats by using 1 part of cement to 2½ parts of sand. There are an infinite number of styles, colors, and trowel effects that may be obtained by the skillful mixing and application of the final layer of stucco. These finishes will be described in detail later in this section.

If factory-mixed stucco is used, simply add water as directed on the package.

Applying Stucco. This first coat, or scratch coat, is the base for all successive coats. In general the following suggestions for its preparation and application have been found practical:

Prepare all stucco in a clean, tight, mixing box. Four planks nailed together with cleats and 8″ boards for the sides make an excellent box. One end should be raised to keep the wet mix ready, while the dry materials are being placed in the higher end of the box. This keeps a steady flow of material ready for use.

Mix with a hoe until all streaks or wet spots have disappeared. The box should be scraped clean after each mix.

Only water that is fit to drink should be used.

Do not combine a new mix with the last of the previous mix. Each should be used completely. This is especially important when using factory mixed stucco.

Weather conditions are most important, as stucco cannot be applied successfully during freezing, cold, or wet weather. If rainstorms threaten, the work should be delayed until there is some prospect of a few clear days. Freezing or *drowning* from rain will cause rapid disintegration and color changes before the initial set. Integral waterproofing or antifreeze solutions should not be used, because of the fat content of these agents. Stucco will not bind to a greasy surface.

The First Coat. Beginning at the highest point, the scratch coat is applied down and around the structure. If possible the work should proceed ahead of the sun, i. e., beginning with the south wall in the early morning, and working around to the west, north, and east sides as rapidly as possible. This system allows the successive coats of stucco sufficient time to get their initial set before the sun speeds up the drying action. Just as soon as the first coat is firm but not hard, it should be *scratched* with a small rake to form a key for the second coat. A small piece of the reinforcing mesh is suitable for this purpose.

The first coat is applied with a plasterer's trowel and hawk. Both tools are used to pick up the mix from the tub or mortar board on the scaffold. A little practice will soon show the most convenient amount to pick up and apply at a steady pace. The trowel should be held at an angle to the work so that the movement of the hand produces a spreading and pressing motion. The idea is to cover the reinforcement, and at the same time force the first coat into the openings, rough spots, and hollows of the wall. An average thickness of 3/8" should be sufficient to embed the reinforcement or to cover roughened brickwork, cement blocks, etc., with the base coat.

Carry the first coat out to the corner guide strips, but not to the full thickness of the wood. The second coat should be applied level and true to the corners, ready for the finish coat. After the straight work has been completed, the corner strips must be removed carefully, and the space filled in with two coats. Care should be taken to seal the joints completely. The final coat will cover the joints.

The use of wood strips or grounds that are 7/8" thick, at all corners, sharp breaks, etc., is the quickest and most practical way of obtaining clean and true corners. Metal corner strips should not be used, as they will rust quickly and start cracks at the weakest part of the stucco shell.

One of the most important factors in stucco work is time. Each coat

must be allowed sufficient time to set and harden in place before the next coat is applied. Failure to observe this simple rule will cause cracking or bulging, shortly after the job appears to be finished perfectly. Depending upon the weather, 3 to 5 days should be allowed between coats. In very

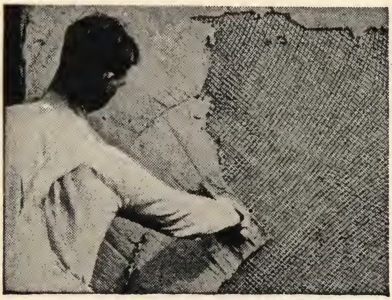


FIG. 5.51. French trowel. A full trowel of mortar. *Courtesy Portland Cement Assn.*

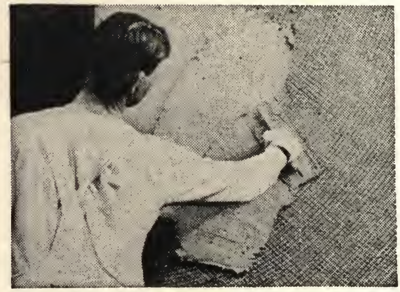


FIG. 5.52. French trowel. A spreading sweep. *Courtesy Portland Cement Assn.*

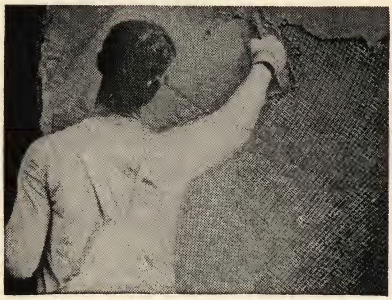


FIG. 5.53. Irregular, overlapping strokes. *Courtesy Portland Cement Assn.*

FIG. 5.54. American texture (stucco). Full upward placing. *Courtesy Portland Cement Assn.*

dry spells each coat should be wet down daily. Do not flood it with a hose, but use a fine spray to wet it evenly.

Second Coat. A few days after the first coat has dried mix the materials to apply the second coat. A plasterer's trowel and hawk are used as shown in Figs. 5.51 to 5.54 to plaster the second coat on the raked first coat. A straightedge or rod is used to level off the surface to a flat plane. This coat must be brought to an even and relatively smooth plane, that meets all

door or window trim, corner furring strips, and reveals or soffits, etc. It is possible to allow some leeway in this coat to meet such conditions as a slight bulge in the middle of a wall, or trim that projects too far. By means of a float and a darby, the entire second coat is finished to an average thickness of 3/8″ to 1/2″.

Some plasterers bring the second coat out to the full depth of the corner strips or other guides that were used to true up the stucco work. In this case the finish coat is simply applied, without using anything but the eye to obtain a smooth or textured surface. The finish coat in a particular style or pattern is applied or built up over the scratch or *browning* coat, as it is sometimes called, *after* all other stucco work is true, free from waves or cracks, and completely set and dry.

The *finish coat* is the most difficult coat to apply, as any mistakes produce glaring spots that cannot be covered or disguised easily. In general the thickness does not exceed 1/4″ except for the styles that require rough lumps or bulges of stucco as part of the finished texture.

There are as many finishes as human ingenuity can produce. They all combine the following steps:

1. Application by means of a particular stroke of the trowel to produce a basic effect.

2. Working over the surface while the stucco is soft enough to permit manipulation without exposing the under coat.

3. A final treatment to produce the surface finish that is to be allowed to harden. This final step may include such operations as: troweling with a special float of cork, carpet, or rough wood; patting or smoothing with the bare hand; scraping with a comb; patting with a large wooden spoon, wad of rags, newspaper, or stiff brush, etc. In one instance an owner insisted that the plasterer put a pair of shoes on his hands and finish the stucco with the prints of his number twelves!

The finish coat should be kept *damp*, not wet, for a few days to prevent hair cracks.

Textures. The following finished stucco textures are used very frequently It should be noted that some preparation was necessary in the browning coat in some cases in order to produce the correct effect in the finish coat. In every case, however, the handling of the trowel produces the basic texture. All other operations soften or accentuate the surfaces left by the trowel.

Colonial Texture. As the colonial or sand floated texture is one of the most popular finishes, every plasterer should know how to create it. A

Fig. 5.55. Colonial texture (stucco). Applying browning coat. *Courtesy Portland Cement Assn.*

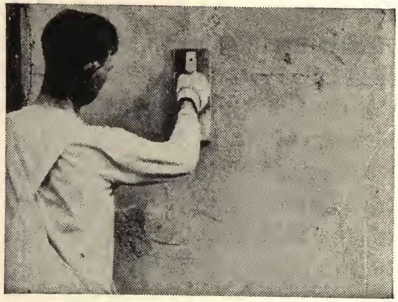


Fig. 5.56. Colonial texture (stucco). Floating browning coat. *Courtesy Portland Cement Assn.*

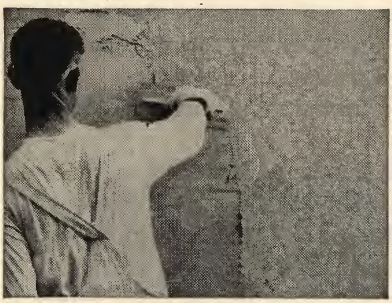


Fig. 5.57. Colonial texture (stucco). Applying finishing coat. *Courtesy Portland Cement Assn.*

Fig. 5.58. Colonial texture (stucco). Carpet floating. *Courtesy Portland Cement Assn.*

Fig. 5.59. English texture (stucco). Short, heavy strokes. *Courtesy Portland Cement Assn.*

Fig. 5.60. English texture (stucco). Applied in all directions. *Courtesy Portland Cement Assn.*

very thin coat of finish must be used to get a regular, even surface. This is applied and spread with the trowel as shown in Fig. 5.55. The brown coat was previously prepared by rubbing down with a wood float, using a circular motion (Fig. 5.56) which produces the even but comparatively coarse surface shown.

When the brown coat is completely dry a thin finish coat is spread (Fig. 5.57). Again, using the circular motion, but this time with a carpet float, this coat is thoroughly rubbed down (Fig. 5.58). As it is being carpet floated the surface should be sprinkled with a plasterer's brush, that is dipped occasionally into a pail of water. This carpet rub results in an even, smooth texture, which shows light markings of the circular rubbing. A surface so finished has much more life to it than a plain sand floated texture. The slight wetting softens the surface and exposes the sand particles of the mortar for an interesting finish.

Simplicity of design, outstanding in colonial architecture, is accentuated by the regular finish and light colors of this texture. White, ivory, or pale cream tones are the favored colors.

English Cottage Texture. Variations in this type of texture, from the light leaf like finish to the one to be described here, are many. This finish is, perhaps, the heaviest in form and texture that can be used, and is most suitable for large, rambling structures. The wood float is used to finish the mortar coat, which varies from ¼″ to ½″ thick. The stroke is short (Fig. 5.59), as the mortar spread is small and in all directions. Overlapping occurs wherever it may in placing the mortar (Figs. 5.60 and 5.61). The use of the float leaves a torn surface where each stroke is applied.

Following the application over a small area, the finish should be softened somewhat by being brushed down with a plasterer's ordinary soft brush. Horizontal sweeps, with the brush held as in Fig. 5.62 are used. This curves over uniformly the rough projecting edges left by the float, rounds off the harsher lines into smooth curves, and smooths the surface to its final appearance.

The shades generally used are the deeper tones of dark red or gray, which are in keeping with the architectural style, enhancing the soft, heavy texture so appropriately used with this manner.

Italian Travertine Texture. To produce this texture successfully it is necessary that the second coat of mortar have a good plasticity, so the second coat should be well sprinkled just before the finish coat is applied, to kill part of the suction. The finish coat is then applied about ⅜″ thick and troweled fairly smooth (Fig. 5.63). Then, using an ordinary whisk broom,

FIG. 5.61. English texture (stucco). Overlapping of strokes. *Courtesy Portland Cement Assn.*

FIG. 5.62. English texture (stucco). Smoothing down with brush. *Courtesy Portland Cement Assn.*

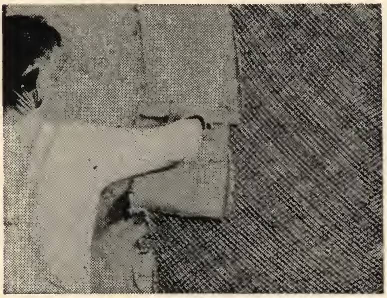


FIG. 5.63. Italian Travertine. Heavy, strong application. *Courtesy Portland Cement Assn.*

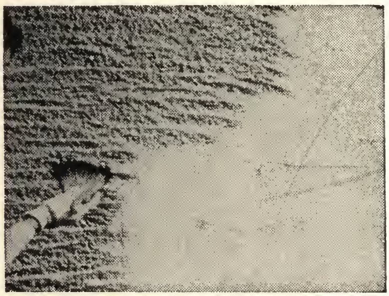


FIG. 5.64. Italian Travertine. Brush held at an angle. *Courtesy Portland Cement Assn.*

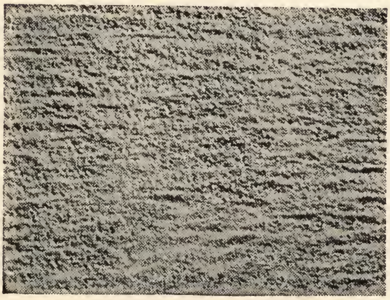


FIG. 5.65. Italian Travertine. Stippled appearance. *Courtesy Portland Cement Assn.*

FIG. 5.66. Italian Travertine. Troweling horizontally. *Courtesy Portland Cement Assn.*

the fresh surface is stippled deeply (Fig. 5.64), pulling up an irregular texture on the surface of the mortar. This stippling should not be too regular in appearance, as the spacing and arrangement of the broom marks are to show the irregular markings of the Italian travertine, which is without regular lines or design (Fig. 5.65).

In stippling, the whisk broom should be held at an angle (Fig. 5.64) to the surface of the wall, to produce the hillocks and hollows which, when troweled, form the veined markings of this texture.

Using the trowel flat against the wall, smooth down with fairly strong pressure the higher portions of the coat to a plain surface (Fig. 5.66). No trowel marks should be left on the finished surface. The lower depressions made by stippling, however, remain in the finish, and in combination with the troweled areas create a very real effect of travertine stone quarried in Italy. Lines may be cut into the surface to produce the effect of masonry. This texture will harmonize with various architectural designs and many color effects may be used effectively.

Chapter 4

BRICKLAYING MATERIALS AND TOOLS

Kinds of Brick . . . Mortar Ingredients . . . Kinds of Mortar . . . Mixing Mortar . . . Coloring Mortar . . . Bricklaying Tools: Trowels, Hammers, Chisels, Level, Plumb Rule, Plumb Bob and Line, Square . . . Measuring Tools: Pocket or Folding Rule, Tape, Sliding T Bevel, Straightedge . . . Lines and Line Pins . . . Rakers . . . Slickers and Jointers

Kinds of Bricks. Bricks are small blocks of clay that have been fired or burned for several weeks at a cherry red heat. The length of the burning varies with the desired strength of the finished brick, and the chemicals in the clay. There are three general types of brick: common brick, face brick, and fire brick.

Common brick include all the ordinary varieties of red brick, without special finish or unusual shape. Every community has its local common brick that suits the demands of that section, and conforms fairly well to the standard size of 8″ in length, 3¾″ in width, and 2¼″ in thickness.

Face brick are those designed to give pleasing appearance to the face of a wall. They are made more carefully and of finer materials than common brick. There is so much variation in color, finish, and size that it is impossible to describe all varieties. In size face brick conform to the standard established for common bricks except for some well known special types. The colors range through the reds, browns, blues, and tans in endless shades and blends. Glazed and enameled brick are also designated as face bricks.

Special molded face brick for window lintels, sills, doorways, water tables, etc., are usually made to order, although in standard sizes and shapes. The demand for these types of brick is so small that they are rarely carried in stock by the average supply yard and must be ordered long in advance from a brick manufacturer.

Fire brick are made of special clays that resist intense heat or flames without crumbling. They are always used where flames or high temperatures come in direct contact with the brickwork. Common or face brick are not designed to resist direct contact with great heat for long periods and for this reason are not suitable for lining fireplaces, chimneys, ovens, etc. The standard size of a fire brick is 9″ long, 4½″ wide, and 2½″ thick.

Mortar Ingredients. The strength of brick masonry depends on the strength of the mortar which binds the bricks into a solid mass. Good mortar is the result of carefully selected materials, proportioned according to good practice and mixed thoroughly by hand or machine. There are four mortar mixes in general use. They are: cement and sand; cement and sand with about 10% of the cement replaced by lime; cement, lime and sand with about equal parts of cement and lime, and ready-mixed cements designed for special conditions, requiring only the addition of water. The principal ingredients of mortar are Portland cement, hydrated lime, sand, and clean water.

A discussion of Portland cement and its uses will be found in the section on Concrete.

Lime is now made from limestone by calcining or burning in kilns. As it comes from the kilns in large lumps it is called *lump lime.* When hydrated or slaked with water by the manufacturer it is called *hydrated lime.* In recent years this form of lime has almost completely superseded lump lime. It is packed in 50 lb. paper bags ready for use.

For all ordinary purposes any sand may be used that is free from vegetable matter, pebbles, and dust. Pit sand or river sand free from mud or silt is excellent. Sea sand is impractical because its mineral salts absorb moisture and cause excessive dampness in masonry. As a general rule, concrete and mortar require the same kind of clean sharp sand, although grits and small pebbles which can be tolerated in concrete sand present serious difficulties in mortar. Sand for mortar must be screened through a No. 4 or ¼″ mesh screen to remove all pebbles.

Kinds of Mortar. Portland cement and sand mortar, 1 part of cement to 3 parts of sand, is used when masonry is exposed to the most severe conditions of load, vibration, fire, water, or weather. It is used frequently to lay the face or exposed portion of the work, while another mortar mix is used for the backing-up masonry because the Portland cement and sand mix is costly when compared with others that give more volume per bag of cement. This mortar sets very quickly and thus retards the speed with which bricks can be laid in it.

Cement and 10% *Lime.* A compromise mix is made frequently by replacing not less than 10%, nor more than 15%, of Portland cement with hydrated lime in a 1 : 3 (1 part of cement to 3 parts of sand by volume) mix. The addition of the small amount of lime makes the mortar more *buttery,* without any appreciable reduction in strength or weather resistance, and enables the mason to speed up the work.

Cement-Lime. The most common mortar for general use, known as a **1 : 1** : 6 mix, is 1 part of Portland cement, 1 part of hydrated lime and 6 parts of sand, all by volume. It is economical and strong enough for most structures. It is similar to the 10% lime mix described above except that a much higher percentage of lime is introduced. The cost per batch is reduced to a point where, compared with other mixes, a substantial saving may be obtained without any dangerous sacrifice in quality.

Ready-mixed Mortar. There are several factory prepared mortar mixes suitable for general masonry work. They are sold by the bag and need only the addition of water to make good mortar, thus eliminating all guesswork in proportioning and mixing each batch of material.

Grout is a thin, watery mortar used to fill cracks or joints in masonry. It is prepared by adding water to a small quantity of mortar until the mixture can be poured readily. Because of its watery consistency it can seep into very small spaces and fill them solidly. Chimneys, retaining walls, and cut stone work must have every joint and void filled solidly to prevent frost or pressure cracks.

Finishing Coat or Topping. An exceptionally hard and smooth cement finish is desirable at times to withstand normal foot traffic or weather conditions. Stair treads, sidewalks, cellar floors, chimney caps, and finished mortar joints in stonework are cement work that require a finishing or *topping* coat of mortar. This hard cement finish should be not less than ½″ or more than 1″ thick. It is prepared by mixing 1 part of cement and 1 part of sand by volume with just enough water to make it workable. The surface is worked up with a steel trowel to a smooth hard finish. If the mortar appears to be too stiff it may be dusted with a little dry cement and then sprinkled with water. The troweling must compact the surface and work the cement and water into the mortar until no streaks or wet spots are noticeable. The surface must be permitted to cure thoroughly before it is exposed for use.

Mixing Mortar. It is easy to mix a batch of good mortar because the necessary tools and equipment are few and the operations simple. For purposes of illustration the 1 : 1 : 6 mix will be used as an example. Build a sturdy mortar box as shown in Fig. 5.67 and obtain a pail or measuring box (Fig. 5.3, Concrete Chapter) to measure the materials correctly. Pile the cement, lime, and sand near the mixing box, and provide a clean water barrel or hose near at hand. A shovel and a hoe are the only tools needed to mix the batch.

Place 6 measured units, pails, or boxes, of dry sand in the mixing box, and

spread 1 unit of cement over the pile. Mix thoroughly with the shovel until no patches of cement show in the sand. Measure a unit of dry hydrated

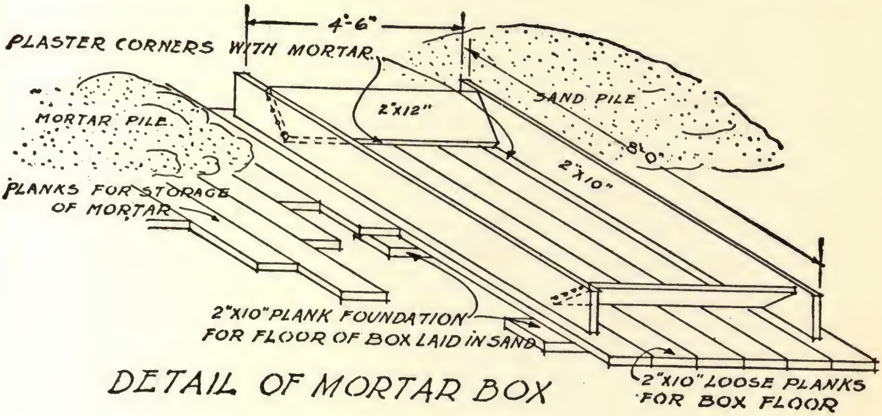


Fig. 5.67.

lime and spread it over the pile of cement and sand. Now hoe or shovel all together for several minutes until the mixture shows no streaks of color, and spread the pile into a ring ready for the water. Figure 5.68 shows mortar mixing in a steel tub. In the figure the tube has sand at its left end, and cement is being added at the right.

Fig. 5.68. Measuring the ingredients for mortar. *Courtesy of the Louisville Cement Co.*

Add water a little at a time, hoeing the cement, lime, and sand into the puddle until the mixture becomes smooth and plastic mortar. If it is too stiff, add more water sparingly until the mortar falls from the hoe in a soft but not watery lump.

Table 1 is a résumé of quantities of materials required, arranged under several different headings for convenience in estimating mortar materials based upon the size of the mortar joint.

TABLE 1. MATERIAL CHART FOR BRICK MASONRY

		Per 1000 Brick						Per 100 Sq. Ft.									Per 1 cu. yd. of Masonry			Per 1 cu. ft. of Masonry		
		8″ and 12″ Wall			12¼″ Wall			8″ Wall			12″ Wall			12¼″ Wall								
		Thickness of Joint			Thickness of Joint			Thickness of Joint			Thickness of Joint			Thickness of Joint			Thickness of Joint			Thickness of Joint		
		⅜″	½″	⅝″	⅜″	½″	⅝″	⅜″	½″	⅝″	⅜″	½″	⅝″	⅜″	½″	⅝″	⅜″	½″	⅝″	⅜″	½″	⅝″
	Brick, Number	—	—	—	—	—	—	1310	1232	1161	1965	1848	1742	1965	1848	1742	514	470	430	19.1	17.4	15.9
	Mortar, Cu. Ft.	11.81	15.05	18.30	12.94	16.18	19.52	15.5	18.6	21.3	23.3	27.8	31.9	25.3	29.9	34.0	6.9	8.7	10.2	0.26	0.32	0.38
Mix 1-0.15-3	Cement, Bags	3.66	4.66	5.67	4.00	5.00	6.04	4.80	5.75	6.60	7.20	8.60	9.88	7.83	9.26	10.52	2.14	2.70	3.16	0.081	0.099	0.118
	Lime, Lbs.	22	28	34	24	30	37	29	35	40	44	52	60	47	56	64	13	16	19	0.48	0.59	0.71
	Sand, Cu. Yd.	0.41	0.52	0.63	0.45	0.56	0.67	0.54	0.64	0.74	0.80	0.96	1.10	0.87	1.03	1.17	0.24	0.30	0.35	0.0090	0.0110	0.0131
Mix 1-1-6	Cement, Bags	1.95	2.48	3.02	2.14	2.67	3.22	2.55	3.07	3.51	3.84	4.58	5.26	4.17	4.93	5.60	1.14	1.43	1.68	0.043	0.053	0.063
	Lime, Lbs.	78	99	121	85	107	129	102	123	141	154	184	210	167	197	224	46	58	68	1.72	2.11	2.51
	Sand, Cu. Yd.	0.44	0.55	0.67	0.48	0.60	0.72	0.57	0.68	0.78	0.86	1.02	1.17	0.93	1.10	1.25	0.26	0.32	0.33	0.0095	0.0117	0.0139
Mix 1-2-9	Cement, Bags	1.31	1.67	2.03	1.44	1.79	2.16	1.72	2.06	2.36	2.58	3.08	3.53	2.80	3.31	3.76	0.77	0.97	1.13	0.029	0.036	0.042
	Lime, Lbs.	105	133	162	115	143	173	138	165	189	207	246	283	224	265	301	61	77	91	2.30	2.84	3.36
	Sand, Cu.Yd.	0.44	0.56	0.68	0.48	0.60	0.72	0.57	0.69	0.79	0.86	1.03	1.18	0.93	1.10	1.26	0.26	0.32	0.38	0.0096	0.0118	0.0141
Mix 1-3-12	Cement, Bags	0.99	1.26	1.53	1.08	1.35	1.63	1.29	1.55	1.78	1.94	2.32	2.66	2.11	2.49	2.83	0.58	0.73	0.85	0.022	0.027	0.032
	Lime, Lbs.	118	151	183	130	162	195	155	186	213	233	278	319	253	299	340	69	87	102	2.60	3.20	3.80
	Sand, Cu. Yd.	0.44	0.56	0.68	0.48	0.60	0.73	0.58	0.69	0.79	0.87	1.03	1.18	0.94	1.11	1.26	0.26	0.33	0.38	0.0096	0.0118	0.0140

Only Standard Size Brick Considered — 2¼″ × 3¾″ × 8″.
All mortar mixes given by volume — in the order of cement, lime, and sand.
The 1-2-9 mix recommended for light load-bearing superstructures.
The 1-1-6 mix recommended for foundation work.
The 1-0.15-3 mix recommended only when loads on masonry exceed 250 lbs. per sq. in.
The reason for these recommendations is that as the lime content is increased the mortar becomes cheaper, more workable and, in our opinion, more likely to make a damp-proof wall.

Hydrated lime used in making calculations.
The table includes no allowances for waste.
All quantities based on assumption that mortar joints are completely filled.
CEMENT — 1 barrel = 4 bags; 1 bag = 1 cu. ft. = 94 lbs.
LIME — 1 bag weighs 50 lbs.; 1 cu. ft. = 40 lbs.; 1 ton = 40 bags.
SAND — Sand quantities based on loose, dry measurement, 2700 lbs. per cu. yd. **A cubic foot of sand weighs from 90 to 120 lbs., depending upon the degree of dampness and tamping.**

TABLE 1. MATERIAL CHART FOR BRICK MASONRY — *Continued*

MORTAR

	MIX 1-0.15-3		MIX 1-1-6		MIX 1-2-9		MIX 1-3-12	
	Per One Cu. Yd.	Per One Cu. Ft.	Per One Cu. Yd.	Per One Cu. Ft.	Per One Cu. Yd.	Per One Cu. Ft.	Per One Cu. Yd.	Per One Cu. Ft.
Cement, Bags	8.36	0.31	4.45	0.165	2.99	0.111	2.25	0.0834
Lime, Lbs.	50	1.86	178	6.59	239	8.85	270	10.0
Sand, Cu. Yd.	0.93	0.0344	0.99	0.0366	1.00	0.0369	1.00	0.0370

In figuring the proportions, the following assumptions have been made: —
That one cu. ft. of cement yields 1.00 cu. ft. of putty; that one cu. ft. of lime yields 0.87 cu. ft. of paste; and one cu. ft. of sand yields 0.70 cu. ft. of absolute volume.
Thus, we get, for instance, for a mix of 1–2–9:

1 cu. ft. of cement yields 1 × 1.00 = 1.00 cu. ft. of putty
2 " " " lime " 2 × 0.87 = 1.74 cu. ft. of paste
9 " " " sand " 9 × 0.70 = 6.30 cu. ft. abs. vol.
Yields 9.04 cu. ft. of mortar

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Courtesy Brick Manufacturers Association of New York, Inc.

Mortar should be used as soon as possible after it is mixed because it loses strength if allowed to stand until it is so stiff that water must be added to make it usable again. When mortar becomes stiff and lumpy but not hard, it may be *tempered* or softened by adding just enough water to make it workable again. Too much water will *drown* the cement in the batch with consequent loss of strength. Most government specifications prohibit the use of retempered mortar for this reason.

Coloring Mortar. Mortar may be colored by adding mineral oxides or vegetable pigments to the batch as it is mixed. Vegetable dyes or organic dyes, however, have a tendency to fade or run as they weather. There are two kinds of mineral oxides that are satisfactory, natural oxides direct from the mine, and manufactured pigments prepared especially for cement work.

The color shades are determined primarily by the proportion of pigment to cement, and not by the proportion of pigment to mortar. For this reason, color specifications give the weight of color pigment to be used per sack of cement. With high grade pigments the amount recommended as a maximum, 10% of the weight of the cement, will usually produce deep shades of color. Lighter shades are obtained by using less pigment, and variations of colors or shades are obtained by mixing two or more pigments. Pure white mortar may be made with white sand, ground limestone, or marble dust.

When preparing colored mortar on the job the pigment and cement are mixed first and then added to the dry sand until no streaks of color show in the mixture. The materials may be proportioned for mortar or topping in the manner outlined in the preceding sections of this chapter.

Bricklaying Tools. Compared with other trades, bricklaying requires comparatively few simple tools. The following list of tools should suffice for the average mechanic.

The *trowel* is the most important tool of the bricklayer. It is triangular in shape with a rounded point and an offset handle. Cheap trowels are not worth buying, as they chip or break easily, and soon lose their shape. A good trowel should be made of tempered steel, and its shank should be set into a hard wood handle. The shank of some trowels is offset only a small distance from the blade. This causes the fingers to dip into the mortar every time the trowel is used, with resulting danger of cracked knuckles and possible infection. It is a good policy, therefore, to select a trowel with sufficient *lift*, or clearance, to the shank so that the fingers may be kept clear of mortar when the trowel is in use.

There are several types of trowels: The *brick trowel* is the largest in size

and the most commonly used. A handy size for general work has a blade 10″ long (Fig. 5.69). The *buttering trowel* (Fig. 5.70) is a short blunt trowel, usually a brick trowel, that has been ground down to a very blunt point. It is used for *buttering* a joint on a brick. When very small joints are re-

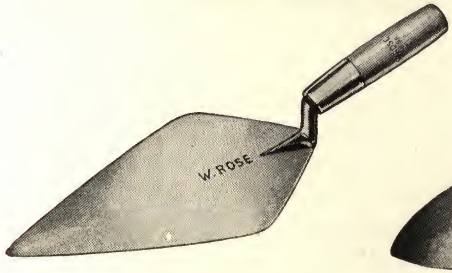


FIG. 5.69. The brick trowel.
Courtesy W. Rose & Bros.

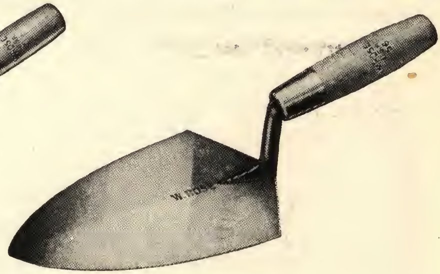


FIG. 5.70. The buttering trowel
Courtesy W. Rose & Bros.

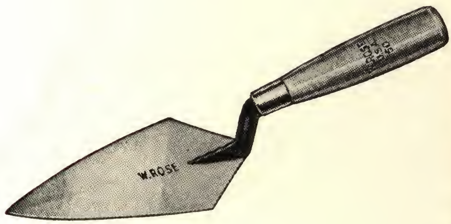


FIG. 5.71. The pointing trowel.
Courtesy W. Rose & Bros.

FIG. 5.72. The brick hammer
Courtesy W. Rose & Bros.

quired this trowel is more convenient than the brick trowel. The term *buttering* means to spread mortar on the bricks, one by one, as they are laid. The *pointing trowel* (Fig. 5.71) is a very small trowel, similar in shape to the brick trowel. This trowel, as its name implies, is used for pointing up joints.

Hammers. The bricklayer uses several types of hammer to meet the needs of various types of work. The *brick hammer* (Fig. 5.72) is a combination of a hammer and a pick. The head is square and the pick end is flat with a tempered edge for cutting. The brick hammer is used for breaking bricks, cutting bricks to exact size with a broad chisel, plumbing corners or other masonry, and similar purposes. It is usually easier to cut brick with the hammer than the trowel.

The *scrutch* (Fig. 5.73) has a flat head with a cutting edge at each end, and a handle in the middle. Sometimes a file is shaped and tempered at both ends and fitted with a handle to form this tool. It is used to cut away and to finish off neatly the broken edges of a cut brick. Face brick should be trimmed to size with a scutch whenever cut edges are visible. This will produce much neater work.

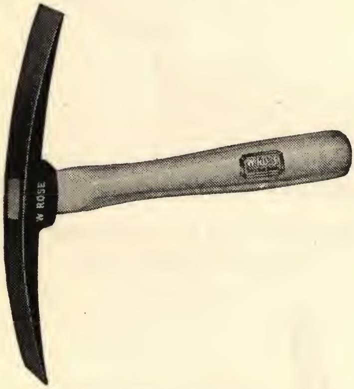


Fig. 5.73. The scrutch. *Courtesy W. Rose & Bros.*

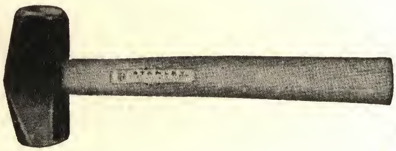


Fig. 5.74. The lump hammer.

Fig. 5.75. The blocking chisel. *Courtesy W. Rose & Bros.*

The *lump hammer* (Fig. 5.74) is the heaviest hammer of all. It is used when extensive cutting of holes, channels, or other work requires extended effort. The hammer is designated by the weight of the head. Thus, a 2 lb. hammer has a steel head weighing 2 lbs. For general work a 3 lb. hammer is most satisfactory.

Chisels. Two or 3 chisels are sufficient for ordinary work. Sometimes a star drill is convenient for cutting holes in masonry, but this may be con-

Fig. 5.76. Cold chisel. *Courtesy W. Rose & Bros.*

sidered a special operation. The *blocking chisel* (Fig. 5.75) is also called a *bolster chisel* or a *set*. It is a broad, thick chisel with a short blade. With

this chisel bricks are cut to size and shape, quickly and accurately. The brick hammer is used with this chisel. The *cold chisel* (Fig. 5.76) is a general purpose tool for cutting holes, steel wire, etc. It should be made of strong steel, tapering to a beveled edge which is tempered. This edge should be ground to an angle of 75°. Two or three cold chisels of different diameters and lengths will be sufficient for the average job. The lump hammer gives the best results with these tools.

The *level* is designed primarily for determining a true horizontal plane but it is usually constructed so that it may be used to determine both horizontal and vertical planes by means of different sets of spirit tubes. It is sometimes called the spirit level, and is used in place of another tool known as the plumb rule, because it combines the functions of the plumb rule and the common level.

Levels are made of wood or metal. Both types are in common use. The wood level is usually a little cheaper than the cast metal level. In practice, both give satisfactory service if used with ordinary care. One of the objections to the wood level is the difficulty of replacing or adjusting the glass tubes in the event of breakage. A well made 3′ level of hard wood or cast aluminum may be used as a makeshift surveying level in laying out ordinary building construction grades.

The *plumb rule* is used to determine accurate plumb lines, that is, lines perpendicular to the plane of the horizon. The ordinary plumb rule is a piece of selected white pine 1⅛″ thick. It may vary in width from 4″ to 6″, and in length from 4′ to 6′. The edges must be absolutely parallel. A line or shallow groove runs down the middle of each face and terminates at an oval hole near one end. A heavy plumb bob is fastened on a line so that it swings freely in the hole, as it is suspended from the other end of the plumb rule. Thus, when the plumb rule is absolutely vertical or when the edge is held against a vertical surface, the line of the plumb bob will lie along the exact center of the rule as indicated by the line or groove on the rule.

Plumb lines are not parallel. It is absolutely necessary to consider this fact when building to any considerable height. The reason for this peculiar phenomenon is that all vertical or plumb lines point to the center of the earth. Therefore, they radiate from a common center like the spokes of a wheel. For this reason, it is impossible for any two plumb lines to be parallel. Some plumb rules have a small gauge fitted into the hole of the plumb rule to assist the mason in allowing for the error in plumbing a corner or wall. It takes time to learn to use a plumb rule correctly. For this reason, most mechanics prefer the spirit level which is easier to read although less accurate for vertical work.

Plumb Bob and Line. A vertical line may be determined very easily by using the force of gravity acting upon a weight on a string. A plumb bob is simply a weight with a sharp point at its lower end, hung on a string. There are many different types of plumb bobs but all of them work on the same principle. This very handy tool is indispensable in building construction.

The Square. The modern steel square is a scientifically designed gauge that will perform an amazing number of calculations. A carpenter's framing square is a good investment. It is better to buy a blued steel with white scale markings because it will not rust and obliterate the markings as quickly as polished steel. A square of average size is the most convenient for general use. One with a 15″ blade and an 8″ tongue will prove satisfactory.

Measuring Tools. From time to time, the mechanic must lay out, check, or measure his work. This involves the use of several measuring tools. Establishing brick courses, story heights, sill heights, length, and thickness of brickwork, etc., require tools which are accurate and easy to use.

Pocket or Folding Rule. This familiar tool is available in two general styles. The 4-fold box wood rule is convenient to handle, but is only 4′ long. The 5′ or 6′ folding rule of steel or wood is more desirable for general work. The mason's rule has inch graduations on one side and brick spacing scales on the other. It provides a convenient and accurate means for gauging the spacing of brick courses, and a quick way of spacing an even number of courses when building corners, putting in sills or coming to any given height. It does away with the necessity of course sticks and is a time saver in laying out a *story pole.* There are ten scales on the mason's scale side of the rule numbered 1, 2, 3, etc. (See Fig. 5.77.) By referring from mason's scale to regular graduations, it is evident that each scale mark numbered 1 is separated from the other scale marks numbered 1 by the same distance—scale 1 measure being $2\frac{3}{8}''$, scale 2 measure $2\frac{1}{2}''$, scale 3 measure $2\frac{9}{16}''$, scale 4 measure $2\frac{5}{8}''$, etc.

Measuring Tape. (See Fig. 5.78.) Steel or linen tapes are made in two convenient sizes, 50′ and 100′. The steel tape is most satisfactory because the markings remain distinct and the tape does not become inaccurate by stretching.

Sliding T Bevel. (See Fig. 5.79.) Sometimes this tool is called a bevel square. A bevel is a try square with an adjustable blade that can be set at

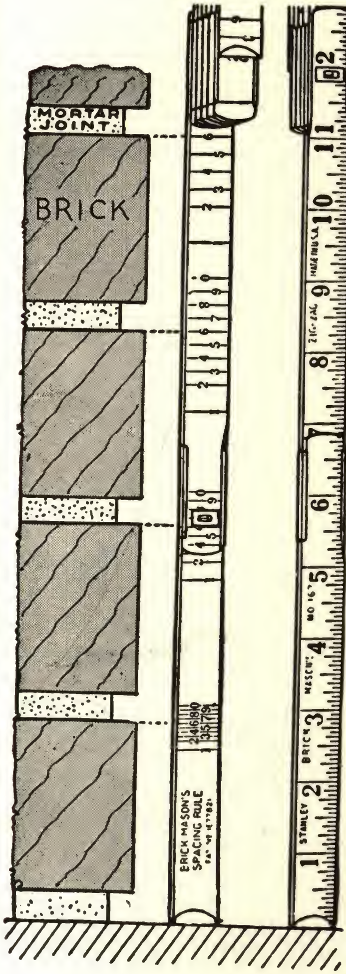


FIG. 5.77. Pocket or folding rule with mason's scale.

any angle with the handle. It may be made of wood or steel. It is indispensable for determining odd angular cuts in brickwork.

FIG. 5.78. Measuring tape.

Story Pole. Brickwork must be laid up accurately, so that it will end at the height necessary for each story, floor, or finished height of a structure. In order to facilitate this work, the bricklayer prepares a story pole or long stick on which is marked the height of each brick

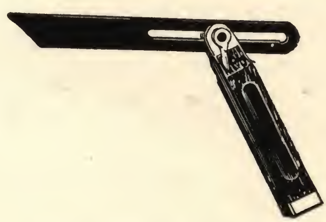


FIG. 5.79. Sliding T bevel.

course, of the window sills, and of any other point to which brickwork must be carried accurately.

To prepare a story pole, select a piece of 1″ × 2″ clear, soft wood, free from twists, cracks, or other defects. Determine the exact heights required

for the brickwork and divide these measurements into brick courses, including the joints. One end of the stick should be shod with a piece of tin. This will prevent excessive wear which would make the story pole inaccurate. Starting from that shod end, lay out brickwork course by course, noting with special marks the heights of sills, window heads, doors, and any other special openings that require the attention of the bricklayer. From time to time the story pole is held against the work as it progresses. Great care should be taken to place the end of the story pole on the same mark each time it is used for checking heights.

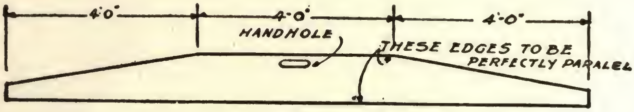


Fig. 5.80.

Straightedge. (Fig. 5.80.) As its name implies, this tool is essentially a long and true straight edge. It is simply a long piece of selected and well seasoned white pine, 1⅛″ to 1⅞″ thick, 6″, 8″, or 10″ wide, and from 10′ to 16′ long. One edge is finished straight and true its entire length; this is

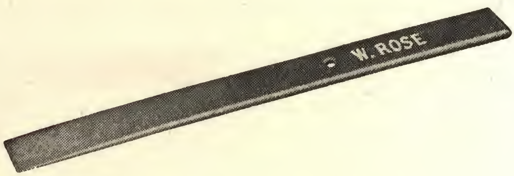


Fig. 5.81. Line pin. *Courtesy W. Rose & Bros.*

the straight edge. The other edge is beveled at both ends, for convenience and to save weight. The middle portion, or about one third of the total length of the upper edge, is finished straight and parallel with the lower and straight edge.

The straightedge is a convenient means of leveling between points. A spirit level placed on the top edge may be used to test the points to be leveled. Abuse or misuse will quickly destroy the accuracy and usefulness of this handy tool.

Lines and Line Pins. Most brickwork is laid to a line that is stretched between portions of the wall built up ahead of the line. To fill in the intervening portion of the wall or walls, a taut line serves as a guide, course by course, as the bricks are laid. It must be strong because the strain on the line must be enough to eliminate most of the sag. A sagging line will cause

FIG. 5.82. Raker.
Courtesy W. Rose & Bros.

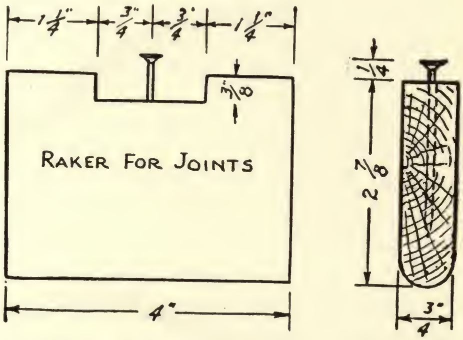


FIG. 5.83. Raker made from wood.

many difficulties such as breaking up the bond, a low spot at the middle of the wall, difficulty in fitting stone or terra cotta trim or wall finishes, etc. The line must be thin for convenience in laying the brick evenly and closely to the line. Knots or splices cause bumps that throw the brickwork out of line. Ordinary fish line is excellent for facework. A fairly good grade of cotton line is sold by the pound, averaging about 500′ to the pound ball. This is satisfactory for average rough work.

Line pins (Fig. 5.81) are used to hold the line on the wall. There are several pins manufactured especially for this purpose. They are about an ⅛″ thick and 8″ long. A 20 penny cut nail 4″ long makes a good line pin. If the end is flattened slightly the pin will hold better in soft mortar. A half dozen of these cut nails are sufficient. Round or wire nails are not good for this work because they slip or turn in the soft mortar. Cut nails will be found more satisfactory.

Rakers. Figure 5.82 shows a tool for raking out mortar to the desired depth. There are many patented rakers on the market, and some of them

can be adjusted for any depth of cut. A very serviceable raker can be made, however, from a piece of hard wood and a nail as shown in Fig. 5.83. The nail may be adjusted to the desired depth of cut. The open space around the nail allows the cut out mortar to drop free of the raker.

FIG. 5.84. Steel finishing tools. *Courtesy W. Rose & Bros.*

Slickers and Jointers. There are so many of these tools on the market that it is impossible to enumerate them. Figure 5.84 shows a typical steel tool for finishing mortar joints. The rounded edge of the raker shown in Fig. 5.83 may be used to strike a concave joint. The only trouble with a wood jointer is that it wears out very quickly, thus changing the appearance of the struck joints as the work progresses.

Chapter 5

BRICKLAYING OPERATIONS

Laying Out Brickwork . . . Troweling Mortar . . . Throwing and Spreading . . . Forming Cross Joints . . . Handling Bricks . . . Laying Bricks . . . Types of Brick Construction: Common Bond, English Bond, Flemish Bond . . . Fireplace Construction: Damper and Smoke Chamber . . . Types of Joint

Laying Out Brickwork. Bricklaying is a skilled trade that requires patience, practice, and some technical knowledge for complete mastery of its fundamental operations. The amateur builder or mason should first attempt to develop some manual dexterity in handling the brick trowel, because it is the most important tool of the trade.

Brickwork usually starts upon a foundation or footing such as the cellar wall of a house or a slab footing under an outdoor fireplace, to mention two typical examples. Before spreading any mortar on the foundation it is necessary to lay out the outside course of bricks around the entire job, keeping to the overall length of each piece of wall. This is called *chasing out the bond,* to make sure that the bricks, and joints between them, fit within the dimensions of the job. Start by laying a whole brick on the foundation exactly where a brick corner is to be. Lay the next whole brick in line with the first, by eye, using the thickness of three leaves of a folding rule as a gauge to approximate the mortar joint (cross joint) between these bricks. Proceed along the entire piece of wall to the next corner, or change of direction, at which point the last full brick must just fit within the overall dimension of the wall. Failure to close exactly may be corrected by making all cross joints a little larger or smaller as necessary until the line of bricks and cross joints fits *exactly* within the limits of the particular piece of brickwork. Now *spot* the position of each cross joint with two marks on the foundation, and continue to chase out the bond for the entire job. When every joint and brick has been marked or spotted on the foundation for the first course of brickwork, the job is ready to be laid up with mortar, beginning with the first bed joint on the foundation.

Some sort of a guide must be provided to secure straight and true brick-

work, because it would be difficult to lay every brick in a straight line by eye. A taut line, stretched the full length of the work to be built and fastened in place with line pins or cut nails, is used for this purpose. This line is supported at both ends by brickwork, that has been built up especially for that purpose. These first portions, called *leads* are usually the corners, because if they are built properly, there is comparatively little chance of a mistake when the balance of the wall between corners is built.

Troweling Mortar. The first mortar joints are those for the corner bricks which will act as leads for the rest of the work. It takes some time to

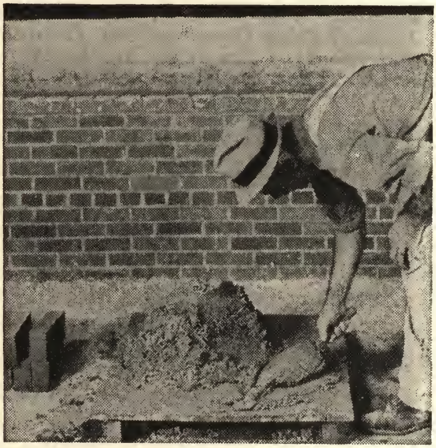


FIG. 5.85. Picking up mortar. *Courtesy of the Louisville Cement Co.*

develop the knack of putting just enough mortar on the wall to form a good bed of mortar or bed joint. This skill is not apparent to the casual observer, until tried. Too much time cannot be devoted to acquiring this trick of the trade because speed and good brickwork depend on this simple, yet exact, operation. The wrist and fingers control the action of the trowel and mortar, and for this reason the trowel must be held properly.

Hold the trowel in the hand so that the butt of the handle rests lightly but firmly in the heel of the palm. The thumb and forefinger should be at the ferrule of the handle, so that they may turn or twist the trowel when necessary. Complete flexibility is necessary, because a cramped hold upon the tool prevents dexterous and speedy handling of mortar.

There is a definite method of picking up a trowelful of mortar from the mortar tub or board (Fig. 5.85). The motion is best described as a scooping semicircular action toward the body, rather than the type of motion

associated with the use of shovel. It is important that the pile of mortar come to rest near the broadest portion or heel of the trowel. This makes it easier to place the mortar properly, and also saves the fingers and wrist from excessive strain. The trick of keeping the mortar from sliding off the trowel while being conveyed to the wall is very simple. Merely give the wrist a little snap to set the mortar firmly on the trowel as it is being lifted from the tub. This drives out any air between the trowel and mortar, thus creating a slight suction that holds the mortar easily on the trowel.

Throwing and Spreading. In practice a bricklayer *throws* enough mortar to lay 4 or 5 bricks, depending on the type of brick and the thickness of the bed joint. The beginner, however, should place only enough mortar to lay one brick at a time. Practice will soon teach the proper amount of mortar to pick up so that more than one brick can be laid with a trowelful of mortar.

The motion that places or lays the trowelful of mortar on the wall may be described as a combined slice and twist of the wrist and fingers. The mortar is slid off the trowel with a motion that starts at arm's length from the body, and ends with the hand and trowel close to the body. Thus, a right-handed man should stand with his right side toward the wall and throw from left to right (Fig. 5.86). When placed properly, the mortar lies heaped up along the middle of the space on which the brick or line of bricks is to be laid.

After the mortar is thrown on the wall it must be spread evenly over the entire area that will become the bed joint (see Fig. 5.87), because each brick must have a full cushion of mortar under it to distribute the load or strain. With the blade of the trowel held at an acute angle, the point is moved up and down slightly as it is drawn along the middle of the thrown mortar, thus squeezing it out into two ridges as shown in Fig. 5.90. The skill of this trick of the trade is in judging the thickness of the mortar ridges, so that the finished bed joint works out accurately and easily as the bricks are laid. Only actual practice can teach the knack of spreading mortar just thick enough so that the proper bed joint forms as the brick is laid to the line (Fig. 5.88).

Sometimes small stones, chips, or lumps of lime appear in the mortar as it is being placed on the wall. Remove all these substances with a deft flip of the trowel point, while spreading the mortar.

If the throwing and spreading operations have been done perfectly, little or no cutting off is necessary, to remove any mortar that may be hanging over the outside edge of the wall. This excess should be cut off quickly and neatly with the trowel along the face of the brickwork that will show as a finished surface. This helps keep the work clean and neat. Any excess

mortar toward the inside of the wall is left in place. Hold the trowel at an angle of about 45° with the face of the wall (Fig. 5.89), and remove the excess

FIG. 5.86. Laying mortar. *Courtesy of the Louisville Cement Co.*

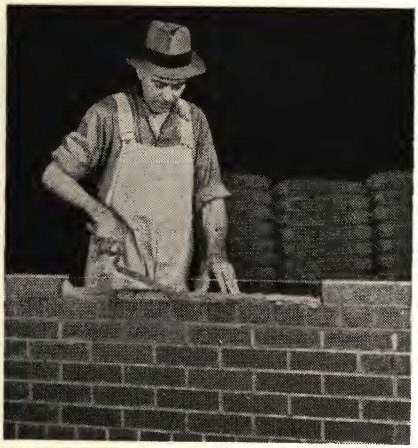


FIG. 5.87. Spreading mortar. *Courtesy of the Louisville Cement Co.*

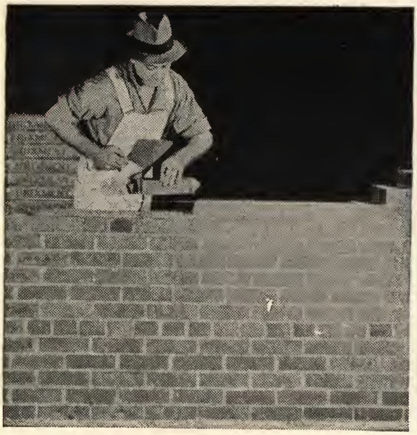


FIG. 5.88. Laying brick to the line. *Courtesy of the Louisville Cement Co.*

FIG. 5.89. Cutting off excess mortar. *Courtesy of the Louisville Cement Co.*

mortar with a single stroke. As this stroke ends, a slight snap of the wrist will cause the mortar to pile up at the tip of the trowel. This lump of mortar

is used without waste of time for a cross joint. This joint may be applied to a brick just laid or to one being held in the hand ready for laying. Mortar must always be cut off so that none of it will project over the edge of the brickwork at any point on the outside face of the wall.

Forming Cross Joints. In addition to the bed joint which is continuous for the entire course of bricks, the joints that separate the bricks from one another are made with the trowel. There are several different methods of performing this operation. The beginner should be cautioned at this point to pay particular attention to the cross joints. The appearance of brickwork may be spoiled or enhanced by the cross joints. Weak, sloppy, or hurried brickwork may be spotted instantly by the slovenly manner with which the cross joints vary over the surface of the wall. Leaking walls, cracks, and many other serious defects can be traced directly to the failure of the mason to fill every cross joint completely to the full depth of the brick. It is impossible to emphasize this point too strongly.

Some bricklayers prefer to spread enough mortar to lay four or five bricks at a time. The dry bricks are placed along the wall just back of the course to be laid, before any mortar is spread. A generous trowelful of mortar is then thrown, spread as shown in Fig. 5.90, and cut off ready for the bricks. The mortar obtained by the cutting off stroke is used deftly to form the cross joints. Note the mortar to form cross joint on the brick about to be laid, Fig. 5.88. Whenever a little extra mortar is needed to form or to fill in a cross joint solidly, it is obtained from the *tail* of the spread mortar. The tail is the end farthest from the bricklayer at the time. This method requires less bending, but it may be used only when the mortar has sufficient lime in it to prevent rapid hardening.

The *pick and dip* method is used in many parts of the country. It seems to be the best method for cement mortar which does not contain lime, because such mortar hardens so rapidly that it is difficult to lay more than one or two bricks at a time. The mason picks a brick with one hand, while dipping just enough mortar to lay that brick. With a smooth motion, the bed joint is laid and readied to receive the brick. The cross joint may be applied to the brick itself as it is held. No time is lost in bedding the brick before the mortar begins to set. With practice this method is very fast, although it requires much more bending and coordination of muscles. Fine or costly face brick, or brickwork laid with very small joints is almost always laid by the pick and dip method. Special shapes and sizes such as ornamental doorways, arches over windows, or any other work that requires

precision and accurate layout, must be laid brick by brick with all joints filled completely.

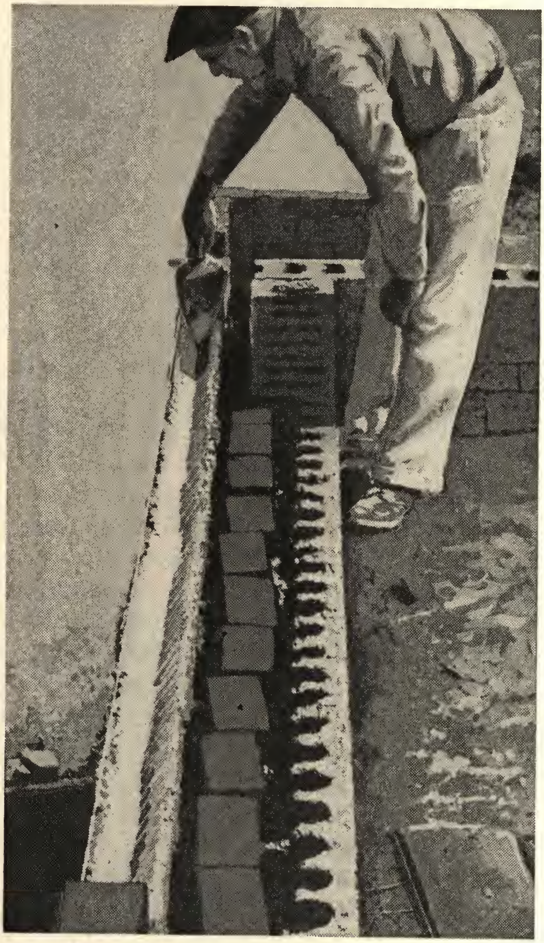


FIG. 5.90. Troweling ridges.

Lining for Long Walls. Where a straight wall of considerable length is to be built, several leads may be erected at convenient points along the wall to act as *triggings*. A trigging is an intermediate support for a line to prevent excessive sagging. At these points the line is held to the proper

brick course height by means of a piece of string or tape. The triggings must always be carried up to level up with the corner leads. Serious difficulties result when a hollow or high spot develops in the middle of a wall because of a carelessly trigged line.

There are several methods of fastening a line on a wall. Patented clamps or holders are available for this purpose but unfortunately they are costly and easily stolen. A pair of 4″ cut nails will hold almost any line that the average mechanic may use. The customary handling of the line puts the tightening end at the right-hand end of the line, that is, the man at the extreme right is responsible for stretching and raising the line to the next course of brick as the work progresses. When a course of brick is completed the man at the tightening end of the line slacks the line immediately and prepares to raise it to the next course. As soon as the line is loosened, the left end is moved up a course and held in place by a cut nail, pin, or brick. The line is then pulled taut at the right-hand end and secured firmly, thus leaving the line swinging free and clear except for any triggings that may be necessary to maintain a perfect level. The next course of brick may now be laid to the line.

Soft or green mortar makes it very difficult to use cut nails for holding the line in position. To overcome this difficulty, and to obtain greater accuracy, the line is carried around the corner angles or leads, whenever possible. The line may thus be raised by merely allowing a little more length, and hooking the line over the corner edge of the desired brick course. As the line is tightened in place, it will jam into the joint, thus seating itself sufficiently to hold its position.

When in position for working, the line should swing just clear of the top outside edges of the lead bricks and exactly level with them. It is very easy to check the leads with a line to ensure that they are aligned with each other. The space between the line and the course of bricks should be exactly the same throughout the entire length of the wall. With the exception of the corner bricks, the line must not touch any brick.

Handling Brick. There is quite a knack to handling bricks as they are being laid. A brick is not a perfectly rectangular lump of clay. In the process of manufacture, it is necessary to make bricks wedge shaped. The top is wider than the bottom on which the trade name, or trade-mark is stamped. Bricks are always laid so that the face with the depression or trade-mark is downward. Common bricks have another peculiarity in that one side is square with the faces, while the opposite side has a slight bevel to it. Close observation of the end of a common brick shows the true

shape very clearly. Common bricks must be laid so that the true face becomes the exposed portion of the brick. A bricklayer developes the knack of picking up a brick with the depression side down, and the true face toward the outside of the wall. This is a great saving in time and labor, as it eliminates many needless motions.

The operations of spreading mortar, picking up a brick correctly, and laying the brick properly must be performed at a steady pace. Both hands

FIG. 5.91. Placing brick in position. *Courtesy of the Louisville Cement Co.*

FIG. 5.92. Tapping brick. *Courtesy of the Louisville Cement Co.*

are used continuously although the trowel is held in one hand. The brick to be laid is held by the tips of the fingers, so that it may be guided firmly into the soft mortar. Placing bricks in position is entirely a finger and wrist action (Fig. 5.91), little or no strength being required if the bed and cross joints have been prepared properly. It is almost impossible to force bricks into place on carelessly formed joints. Speed in bricklaying depends almost entirely upon proper preparation of the joints. Some bricklayers have the habit of tapping each brick with the trowel (Fig. 5.92) as the final step in forcing the brick into place. This may be necessary in some cases when the mortar is a little stiff but for the most part it is unnecessary if the bed joint is of the proper size.

Laying Brick. The following steps or motions should be observed carefully in laying a brick: (1) Hold the brick with the fingers only, the squared edge toward the outside face of the wall, and the face with the depression in it downward. (2) Bring the brick into position, over the mortar joint,

with the upper edge parallel with, and inside of the line. (3) The actual laying motion is really three motions in one. They are accomplished so smoothly that they appear to be very simple. By skillful action of the fingers the brick is: (1) pressed down upon the bed joint, (2) shoved toward the cross joint, and (3) rolled outward toward the line so that the top edge of the brick comes to rest parallel with, and just clearing the line. It may be necessary to tap lightly with the trowel to align the brick with the line.

The rolling motion forces some of the soft mortar out to the face of the wall. This is removed with a single stroke of the trowel. This stroke is not a scraping motion, but a cutting action that removes the excess mortar, and leaves the brickwork clean. When mortar joints appear smeared and sloppy, it is proof that the mortar was scraped off instead of being cut off. The trowel is always held so that the excess mortar collects on the trowel. Some bricklayers use this mortar for cross joints, or apply it when needed to fill the wall. It is considered poor practice to throw mortar toward the tub, as the resulting spatter may dirty the work or other material waiting to be built into the wall.

Do not attempt to straighten or correct brickwork after the mortar has begun to take hold. The first bond with the mortar is the best, because hammering or shifting bricks may be accomplished only by breaking the mortar bond. The cracks thus created, though small, will never make bond again. Broken joints are a common cause of damp walls.

Every bricklayer develops his own method of laying brick. Some spread and lay several bricks before cutting off the joints. Others lay and finish each brick one by one. The fingers and wrist play the most important part, as it is necessary to develop a *feel* for placing each brick properly. The eye is trained to guide plumb or vertical alignment almost entirely. The amateur bricklayer should devote most of his time to acquiring the ability to place a brick gently but firmly upon a good joint with a single motion. The pressure on the palm of the hand and fingers should indicate at once whether or not the brick is laid properly.

A skillful mechanic prides himself on never touching the line. There is a simple and easy method of placing the brick in position, without touching the line. The following method will save time, temper, and the fingers: Hold the brick with the tips of the thumb and fingers while placing the brick on top of the mortar. As the brick takes hold, release it just before the fingers touch the line. Bring the top of the brick and the outside edge level to the line, by quickly shifting the fingers to the top of the brick, and applying sufficient pressure to set the brick in place. A few taps of the trowel

may be necessary to complete the operation. The amateur should practice laying to a line to acquire the habit of rolling the thumb and fingers up and out of the way, as the brick goes down to the line.

Types of Brick Construction. *Bond*, in the sense used so far in the text, refers only to the adherence of bricks and mortar or of other elements in masonry construction. Another meaning of the word, however, concerns the arrangement of the bricks through the cross section or depth of the wall.

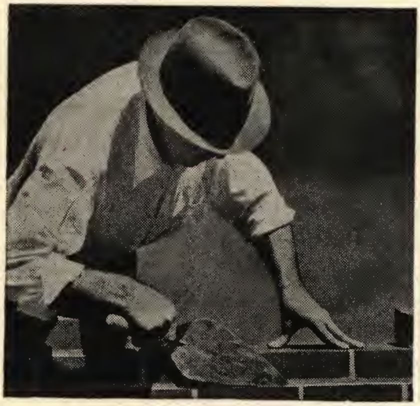


FIG. 5.93. Striking a joint with a trowel. *Courtesy of the Louisville Cement Co.*

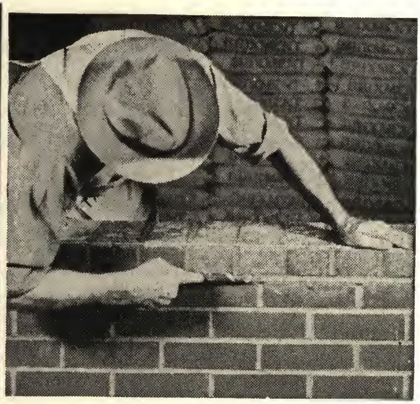
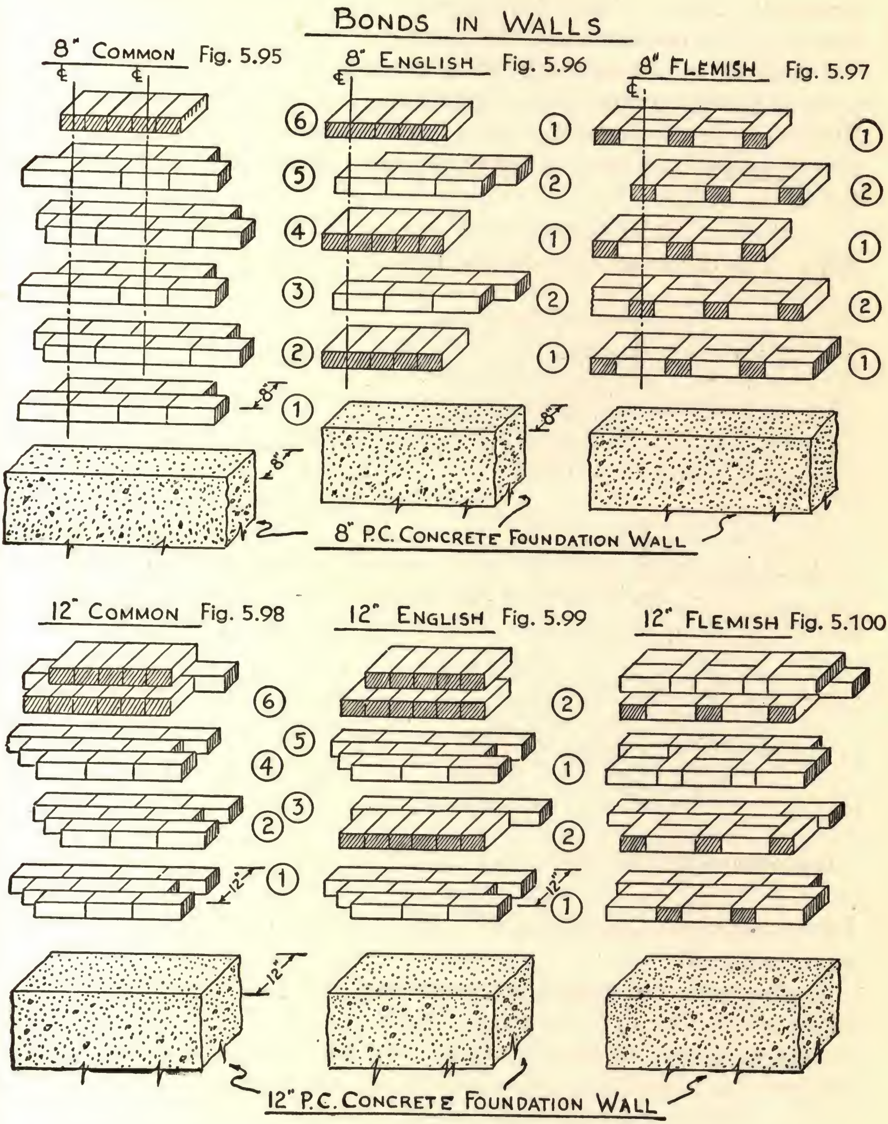


FIG. 5.94. Pointing. *Courtesy of the Louisville Cement Co.*

A properly bonded wall must have many bricks crossing over and cemented to one another to prevent the wall from splitting under vibration, slight settlement, or heavy load.

It is obvious that by laying bricks crosswise, called *headers*, the wall may be built to any thickness that is a multiple of the width of a brick. Thus, with bricks of a nominal width of 4″, walls 8″, 12″, 16″, 20″, etc., thick may be constructed. Figures 5.95 to 5.100 inclusive show how walls may be built of any thickness that is a multiple of this basic 4″ width of a standard brick.

Common Bond. Figure 5.95 illustrates a wall 8″ thick, laid up in common bond, consisting of 5 courses of *stretchers*, bricks laid lengthwise, and a sixth course of headers. Operations in laying headers are shown in Figs. 5.93 and 5.94. If this arrangement is taken as a unit, these 6 courses are known as a *set-up* in the trade. As shown in the sketch, begin the work with a course of stretchers, laid on top of the foundation that will support the fin-



FIGS. 5.95 to 5.100 inclusive.

ished wall. Back up the outside or face course with another row of stretchers as shown, thus creating the 8″ thickness of the brick wall.

The second to fifth courses inclusive are stretchers, laid so that the cross joints of alternate courses line up plumb and true. The two heavy dashed lines in the sketch, marked ℄ (center line) are intended to illustrate clearly this perpendicular pattern of the cross joints in every other course on the face of the wall.

The sixth or header course extends through the wall and is flush on both sides. This course controls the thickness of the wall by the length of the

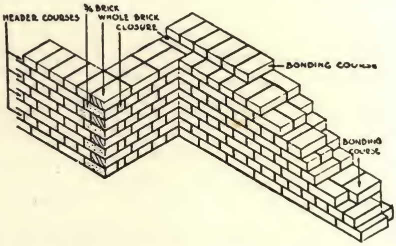


Fig. 5.101. English bond with Dutch corner on left side of projecting angle and English corner on right side (showing closures).

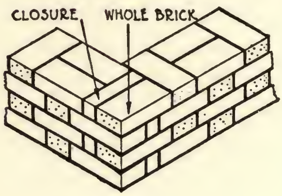


Fig. 5.102.

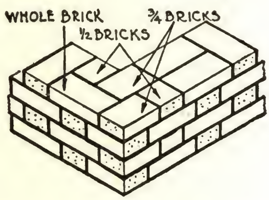


Fig. 5.103. Corners formed with and without closers.

bricks themselves, the standard 8″. Every other header must be centered on a cross joint.

English Bond. In a general sense the English bond is merely a variation of the common bond, with a set-up of only 2 courses. Figure 5.96 shows 5 courses of alternating rows of headers and stretchers, or two and a half set-ups. Note how the cross joints plumb up exactly every other course in height. The ℄ (center line) indicates this clearly for the headers, as an example. As usual the backing-up rows of brick break joints through the wall in every other course to make good bond across the wall. The cross joints of the stretcher courses must be plumb also, over one another. Figure 5.107

shows how to lay up an inside or an outside corner in this bond. The so-called *Dutch* corner uses a three quarter brick to start each stretcher course (as shown on the left face of the corner); or another method known as the *English* corner may be followed in which a *closer* piece is used next to the corner header in each heading course. The right side of the corner in the illustration shows this method clearly with the closer pieces indicated by an arrow. Figures 5.99, 5.104, and 5.105 are included to give additional help in understanding the bond in an 8″ or 12″ wall.

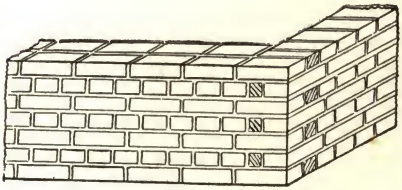


FIG. 5.104. English bond. Alternate courses of headers and stretchers. The second brick of the heading course is a closer (Queen). Note: All headers and stretchers are in vertical alignment.

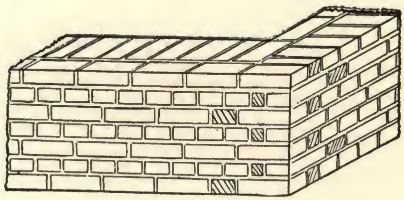


FIG. 5.105. English cross bond. Alternate courses of headers and stretchers. The second brick of alternate stretcher courses is a header. The second brick of each header course is a closer. Note that stretchers are not in vertical alignment. Headers are in vertical alignment.

Flemish bond is an attractive arrangement of alternate stretchers and headers in the same course, with a shift each successive course, so that every header centers over the middle of every stretcher in the course just below. Figures 5.102 and 5.103 show how this bond may be started by either of two methods. The first, Fig. 5.102, uses a three quarter brick on the corners to get the headers centered properly over the stretchers, while the other method, Fig. 5.103, requires a 2″ piece or *queen* closer next to the corner whole brick to start the headers and stretchers properly.

Figure 5.97 shows an 8″ wall laid up in Flemish bond with the headers and stretchers centered over one another as indicated by the center line. The bond through the wall for a 12″ wall is shown course by course in Figs. 5.100 and 5.106. Note that courses one and two are repeated until the wall is completed.

Fireplace Construction. Since the dawn of civilization the hearth and fireplace have been an intimate and necessary part of the home. In Colonial times the great stone or brick chimney in the center of the house served

several fireplaces on the first or second stories. With the development of central heating systems, the fireplace became unnecessary as a source of heat and became purely decorative or merely a pleasant spot to enjoy the burning embers at leisure. A well designed and built fireplace will make any home more cheerful. Like any successful project, there are certain rules that must be observed to ensure complete satisfaction in the finished job. The suggestions that follow are intended to outline the most important considerations in building a fireplace that will burn without smoking.

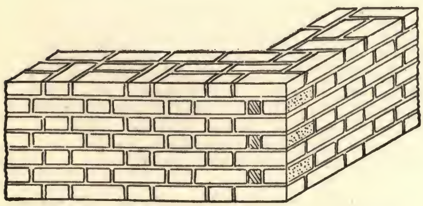


FIG. 5.106. Flemish bond. Alternate stretchers and headers in the same course. There are two methods of beginning, one showing the second brick in alternate courses as a Queen closer and the other showing alternate courses beginning with a ¾ brick.

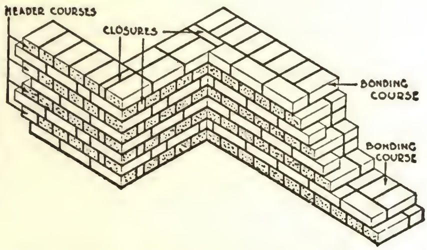


FIG. 5.107. English cross or Dutch bond. Corners started with closers.

There is a definite relationship between the size of the fireplace opening and the size of the chimney flue. The dimensions of the fireplace should be determined before the chimney is built unless the flue is already built. In that case, the size of the fireplace opening will depend upon the size of the flue in the chimney. Every fireplace must have its own flue, but more than one flue may be built into one chimney.

There is one rule for determining the relation between flue and fireplace opening that has stood the test of time. It is: the area of the fireplace opening should be not more than 12½ times the cross section of the flue. Another way of stating this is that the cross section of the flue should be 8% of the area, width multiplied by height, of the actual fireplace opening. It is better to have the flue too large than too small: the damper can cut down too much draft, but an inadequate flue can never serve the fire properly.

The following table of dimensions and areas should be a help in determining flue sizes and fireplace openings.

TABLE 1. TABLE OF DIMENSIONS, SHOWING AREAS OF STANDARD FLUE LININGS AS ESTABLISHED BY EASTERN CLAY PRODUCTS' ASSOCIATION

Rectangular		Round	
Outside Dimensions of Flue Linings, Inches	Inside Cross Sectional Area of Flue, Sq. In.	Inside Diameter of Flue Linings, Inches	Inside Cross Sectional Area of Flue Linings, Sq. In.
4½ × 8½	23.56	6	28.27
4½ × 13	38.19	8	50.26
7½ × 7½	39.06	10	78.54
8½ × 8½	52.56	12	113.0
8½ × 13	80.5	15	176.7
8½ × 18	109.69	18	254.4
13 × 13	126.56	20	314.1
13 × 18	182.84	22	380.13
18 × 18	248.06	24	452.3

Rectangular, No Allowance for Radial Corners

Damper and Smoke Chamber. A patent damper is good insurance against failure of the fireplace to draw properly, although no damper can compensate for the lack of draft if the flue is too small for the size of the fireplace opening.

FIG. 5.108. Poker control. Diagram shows how this damper is controlled by hooking an ordinary poker into ring and pushing or pulling until desired position is reached. Ring projects 5″ below flange of damper.

Figures 5.108 and 5.109 show two dampers with their respective operating mechanisms. Figure 5.112 is a cross section of a typical fireplace and chimney. Notice that the damper is placed close to the front of the fireplace against the front wall. The back wall slopes forward to support the rear flange of the damper, while the front flange supports the masonry across the opening of the fireplace. The sloping back wall helps form the smoke shelf,

shown in Fig. 5.112, and the side flanges of the damper rest upon the splayed side walls of the fireplace. Figure 5.111 illustrates the principle of properly

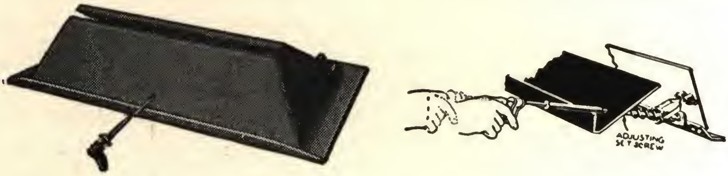


FIG. 5.109. Rotary control. To open or close this damper you rotate the knob that protrudes through mantel front. Diagram shows mechanism. Distance from under side of front flange to center line of operating rod is 1½″.

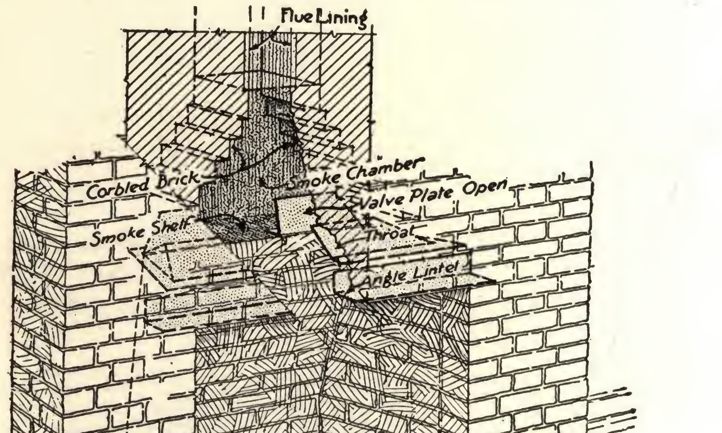


FIG. 5.110. Cutaway view of correctly designed fireplace.

designed side and rear walls, based on the figures in Table 2 of fireplace dimensions.

In Figs. 5.110 and 5.112 the space just above the damper is labeled *smoke chamber*. This is an open space with sides that slope from the damper to the clay flue forming a shape somewhat like a pyramid. The sides should slope from damper to flue about 7″ in 1′ of height, thus determining the starting point of the flue. Too abrupt a slope reduces the size of the smoke chamber, and prevents the smoke from rising quickly. The size of the smoke chamber, compared with the flue area acts to reduce the force of

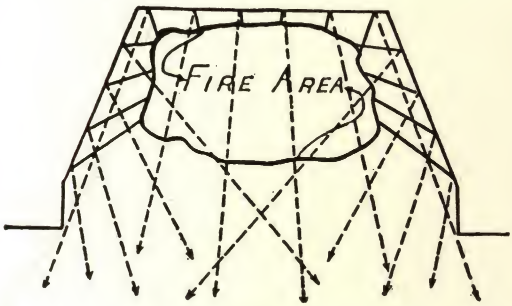


FIG. 5.111. Illustrating heat radiation from a fireplace, having properly designed side and rear walls.

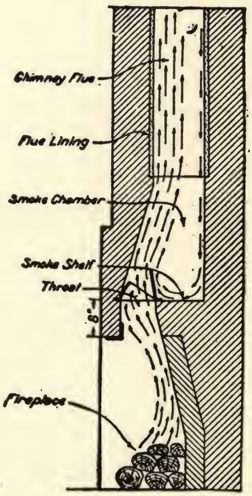


FIG. 5.112. Showing how down-draft is diverted upward from smoke-shelf.

extra violent puffs of wind that might force smoke down through the damper and out into the room.

At times it may be necessary to slope the fireplace flue to one side. Such change of direction should begin *above* the smoke chamber which should be built as if the flue were to be straight. Unless both sides of the smoke chamber slant evenly to the top where the flue starts, the chimney will draw unevenly on the two sides. Some builders use and recommend a sheet metal smoke chamber, but this is an unnecessary expense if the chamber is built as shown in the sketches and photographs in this section.

Just back of the damper is a flat horizontal surface called the smoke shelf. Figure 5.112 shows this clearly, as well as its function to turn the downdrafts upward just as they strike the damper. This shelf is an absolute necessity

TABLE 5.2. Dimensions for various fireplace openings.

Finished Fireplace Opening							Rough Brickwork			
Width	Height	Depth	Back	Vertical Back Wall	Sloped Back Wall	Throat	width	depth	Smoke chamber	slope of smoke chamber
A	B	C	D	E	F	G.	H	I	J	K
In.	In	In.	In	In.	In.	In.	In.	In	In.	In.
24	28	16	11	14	18	8	37	20	24	14
28	28	16	15	14	18	8	42	20	25	14½
30	30	16	17	14	20	8	42	20	25	14½
34	30	16	21	14	20	8	46	20	28	16½
36	30	16	23	14	20	8	46	20	28	16½
40	30	16	27	14	20	8	50	20	32	18½
42	30	16	29	14	20	8	54	20	35	20½
48	33	18	33	14	23	8	59	22	40	23
54	36	20	37	14	26	12	67	24	42	24½
60	39	22	42	14	29	12	71	26	45	26½
72	40	22	54	14	30	12	83	26	56	32½

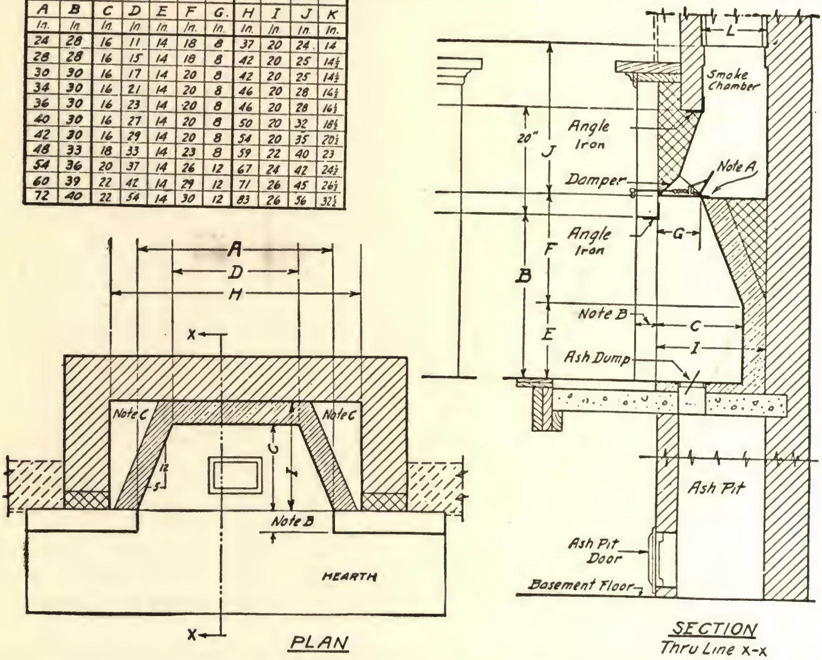


FIG. 5.113. Construction sketch of fireplace.

Note A. The back flange of the damper must be protected from intense heat, by being fully supported and shielded by the back wall masonry.

Note B. The drawing shows the brick fireplace front as 4″ thick. No dimensions are given for this particular part of the fireplace because of the variety of materials that may be used to face the opening, such as marble, stone, tile, etc., all of which have different thicknesses.

Note C. These hollow spaces should be filled with masonry to form a solid backing. If it is necessary to include one or more furnace flues in either space beside the fireplace, the overall dimensions of the chimney must be increased to allow at least 8″ of solid brickwork on all sides of each flue.

to prevent occasional back drafts from puffing smoke down through the damper when high winds create alternate up-drafts and down-drafts in the chimney.

Figure 5.113 shows construction details of a fireplace in a brick chimney. At the right is a vertical section through the fireplace, damper, mantle, etc., showing these parts in their correct position as if a knife had cut through the finished job. The illustration shows a rotary control damper installed. Figures 5.108 and 5.109 show the details of both poker and rotary control dampers.

Types of Joint. The mortar in which bricks are laid binds the wall into a solid mass. All joints that show on the exterior face of brickwork should be solid and full of mortar. Any voids or holes that might allow water to get into the wall will cause serious leakage or damage to the wall itself, and to the interior finish of the building. It is customary to finish off, every joint in a manner which will smooth the mortar in a pleasing style, and which, at the same time, will eliminate any small rough spots through which moisture could penetrate. This operation is called *striking* the joints. Brick joints may vary in thickness, type, and finish. The following are a few of the more common joints, which are used to make both bed joints (horizontal), and cross joints (vertical).

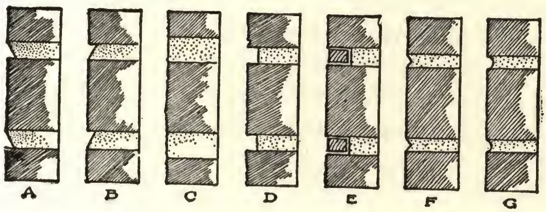


FIG. 5.114. A, struck joint. B, weathered joint. C, flush or plain cut joint. D, raked joint. E, stripped joint. F, "V" joint. G, concave joint.

Rough, or Flush Joint. This joint is formed easily and quickly by simply cutting off the excess mortar from the bed and cross joints with the edge of the trowel. No other finishing operation is necessary. Interior wall surfaces, such as wall surfaces backing up face brick, party walls, etc., may be laid with this joint. It should be noted that many small voids and rough spots remain in this joint. It is considered unwise to use this joint on any surface exposed to the weather, or to excessive dampness, because the porous surface absorbs moisture more readily than a smooth finished joint (Fig. 5.114C).

Struck Up Joint. This is the quickest and most easily made joint. The mortar is allowed a few minutes to set, and then the point of the trowel is drawn quickly and firmly along the joint. The trowel is held at a slight angle away from the wall, so that only the point comes in contact with the soft mortar. The cross joints are struck first, and care is taken to fill in any small holes or voids in the joints. The bed joints are struck last, thus making one continuous smooth joint for the entire course of brickwork (Fig. 5.114A).

Weathered Joint. This joint is similar to the struck joint, in some respects. Its cross joints are struck with the point of the trowel as are the cross joints in the struck up type of joint. The bed joints, however, are struck with the point of the trowel, so that the point slips under the next higher course of brick. This forces the mortar in at the top of the joint, leaving the lower edge of each brick course exposed. This joint casts a small shadow, thus creating horizontal bands of shadow. In some types of design, this joint results in a pleasing and interesting play of light and shadow over the walled surface (Fig. 5.114B).

Raked Joint. This joint is cut off flush with the trowel, and allowed a few minutes to set. A steel rake or jointer is then used to rake out the mortar between the bricks to the desired depth of the joint. The cross joints are raked out first, and then the bed joints. Frequently the joint is finished by running a steel slicker, or a smooth wooden stick along the joint to fill in any small voids or holes. Another method of producing a raked joint is to rake the joint quickly with a stick while the mortar is soft. A few minutes later a stiff broom is brushed across the wall surface to remove any excess mortar, and to smooth out the joints. This method results in a textured appearance (Figs. 5.114D).

Rodded, or Stripped, Joint. This is the most precise joint of all. It is slower to make, and more expensive than any other joint. It is necessary to provide wooden strips of convenient length, having a thickness that is the exact thickness of the mortar joint desired. It is the common practice to make the width of these strips the correct depth of the joint. The preparation of the wood strips is one of the factors that increase the cost of the rodded joint. The wooden strips, or *rods*, are placed along the front edge of a brick course. The bed of mortar is placed behind, and flush with the top of the strip. The next course of brick is then laid, the strip holding the upper brick to the correct depth and height of joint. The cross joints are gauged by eye, and raked out and finished with a slicker, after the mortar has set slightly. The strips are not removed until the bed joints have set

up sufficiently to hold their shape and size. The final operation is to finish all joints, where necessary, with a few touches of a steel slicker (Fig. 5.114E).

Concave Joint. A piece of pipe, or an iron rod bent to form a convenient hand hold, may be used to form this joint. As usual, the cross joints are struck up first, and the bed joints last (Fig. 5.114G).

V Joint. A piece of square steel may be used to form the V, although special jointers are made for this purpose. A small piece of board may be used, however, if it is held so that the square edge forms the V against the soft mortar. This is a very rough method of producing the joint (Fig. 5.114F).

The *ruled joint,* also called the *Homewood Joint,* is one of the oldest and most beautiful of brick joints, and has been used most effectively in the restoration work at Williamsburg, Virginia. It requires a considerable amount of practice and skill to produce the proper effect. The mortar joints are first cut off flush, and then struck up very carefully, leaving every brick free from excess mortar. Each brick must be surrounded by clean and well struck joints. When the mortar joints are fairly well set up, every cross joint and bed joint is rodded. This operation requires the use of a straightedge and a small trowel, or a V jointer. A thin line is cut with the tip of the trowel or the V jointer along the exact middle of each joint. This precise operation requires considerable practice, as all of these lines must be kept parallel. The cross joints are struck first, and care must be taken that this groove does not extend beyond the point where it will meet the horizontal groove to be cut into the bed joint. The bed joints are then grooved in the exact middle, thus connecting all of the cross joint grooves. All intersections of the grooves must be clean and precise. Any mistakes should be removed by restriking and regrooving the joints.

Chapter 6

GLOSSARY OF BRICKLAYING TERMS

Air Space. A cavity or space in the wall.

All stretcher Bond. Bond showing only stretchers on the face of the wall.

Alumina. A mineral contained in the clay used for brickmaking.

Angle Iron. A piece of structural steel in the form of a right angle, used to hold up brickwork over doors, windows, etc.

Arch. Curved or flat piece of brickwork strong enough to carry a load over such spaces as doors, windows, etc.

Arris. The point where two surfaces meet to form an angle.

Backboard. A temporary board on the outside edge of a scaffold, used to prevent material from falling off.

Backing. The part of the wall behind the face brick.

Backing Up. Building the inside portion of a brick wall after the outside or face bricks have been built header high.

Backing of a Wall. The rough inner face of a wall; earth filled in behind a retaining wall, etc.

Bat. A broken brick, generally used for filling in the inside courses of a wall. It may be used as a false or "snap" header also.

Batter. The backward or inward slope of the face of a wall. The opposite to overhang.

Bearing Wall or Partition. A wall that supports floor or roof beams, other walls or partitions, etc.

Bed. The horizontal surface on which the bricks of a wall lie in courses. Also, the mortar on which the brick rest.

Bed Joint. The joint between two horizontal courses of brick.

Belt Course. A horizontal course of brick or other material. Sometimes it projects slightly to cast a shadow.

Bench Mark. A well defined mark, accurately established, in a protected location on some solid object. It is used as the principal point of reference for all measurements.

Blocking. A method of building the end of a brick wall with alternating spaces and blocks of brickwork. This permits a neat joint between two pieces of brickwork built at different times.

Bond. The arrangement of bricks in various ways to obtain longitudinal and transverse strength in the wall. At the same time an interesting pattern may be created on the exposed face of the brickwork.

Breaking Joints. Laying bricks so that no two vertical joints come immediately over one another. This is very important.

Breast of a Window. The masonry forming the back of the recess or wall directly under a window sill.

Brick Veneer. The outer facing of brickwork used to cover a wall built of other material. It is most commonly used in reference to brickwork inclosing a frame building.

Bulging. Swelling.

Bull Nose Brick. Bricks made with one or more quarter round ends or corners. Used at corners or angles where a sharp corner would be undesirable.

Buttering. Spreading mortar on a brick before it is laid.

Buttered Joint. A very thin mortar joint made by scraping a small quantity of mortar along all 4 edges of a brick to form the bed and cross joints.

Camber. A very slight rise at the center of a flat arch. This prevents the optical illusion of a sag in the middle.

Cavity Wall. A wall which has an air space built in, or a series of cells, usually just back of the outside 4″ brickwork.

Cell. One of the hollow spaces in a hollow tile, or cement block.

Cement. A mixture of special clays and limestone, burned, and pulverized until it is finer than face powder.

Center. A temporary support or form to hold up arched work while it is being built. It may also mean the middle point.

Chase. A vertical recess or groove in the face of a wall. It is usually built as the wall goes up. Plumbing, heating, or other pipes are concealed in the recess under the lath and plaster finish.

Chimney Breast. The high and wide projection at the base of a fireplace that surrounds the space for the fire, the damper, and the smoke chamber.

Closer. An irregular portion of a brick, used to fill any space of less than brick length.

Closure. A header split in half, although sometimes the term is applied to a three quarter brick.

Code (Building). A set of laws or regulations governing the planning, materials, and workmanship in building construction within a particular community.

Common Bond. A brick pattern in which every sixth or seventh course of bricks is a header course. All other courses are stretchers.

Coping. The course of work that finishes the top of a masonry wall. It must be waterproof and weather resisting. Stone, artificial cast stone, vitrified tile, slate, and sheet metal are cut, cast, or formed to make a neat and attractive cap or finished top.

Corbel. One or more courses of brick built out from the wall to form a support, ornamental feature, or fire stop.

Corbel Out. To build a corbel of brick or stone.

Course. A horizontal row of bricks in a wall.

Cross Joint. The joint between the two ends of a brick.

Crowding the Line. Laying the bricks in such a way that the line is pushed out of its correct position on the wall. This may cause a bulge in the brickwork or make the wall overhang.

Crown. The highest point of an arch.

Culling. Sorting brick for size, color, and quality.

Culls. The odds and ends or bricks rejected in sorting.

Diaper. Any repeated and continuous pattern in brickwork. The various bonds are good examples of this, although the term is usually applied to diamond or other diagonal patterns.

Face. The long narrow side of a brick.

Filling In. Laying the center of a wall between the face and back. Only walls 12″ or more in width can be filled in.

Fire Clay. A light fluffy clay that must be used for laying fire bricks. It makes the only mortar that can resist heat and flame.

Fire Stop. A projection of brickwork from walls for the full depth of the floor joists. This prevents fire from mushrooming through the spaces between the plaster and the masonry walls.

Flat Arch. An arch or span member built with a flat top and bottom. Most flat arches rest upon steel angle irons.

Flue Lining. Burned clay hollow tile used to line chimney flues for protection against fire penetration of the masonry. They are available in many shapes and sizes, usually in 2′ lengths.

Flushed. Filled up to the surface or leveled off.

Full Header. A full brick laid across the wall so that only the end is exposed.

Frame High. The height of the top of door, window, or other frames against which brickwork must be built. Masonry work usually levels up

with the top of a frame, so that the lintel or other structural member may span the opening from brick to brick.

Grout. Rich mortar made very thin so that it will run easily into joints or cracks and fill them.

Header. A brick laid so that the end of the brick is exposed in the face of the wall. Headers act to bind a wall together.

Hearth. The portion of the floor of a fireplace that extends out into the room. It usually rests upon an arch built out from the base of the chimney.

Jack Arch. A flat arch.

Jamb. The flat side of an opening.

Key. The center stone or brick of an arch.

Lap. The distance one brick extends over another.

Lateral Thrust. The pressure that any load or force exerts sideways or through the ends of the members.

Lead. A part of the wall at the corners, or elsewhere when needed, that is built as a guide in advance of the balance of the work. The line for masonry work is always strung between two leads that have been built carefully for this purpose.

Lime Putty. Slaked or hydrated lime mixed with water until it forms a soft putty like mixture.

Lintel. A horizontal support for masonry work. It is usually a steel angle or a combination of steel channels and an angle.

Neat Cement. Pure Portland cement with just enough water added to make the mixture workable. No sand is added.

Nogging. A filling of brick or masonry between wood structural members, thus creating a masonry wall carried on wood joists.

Outrigger. A joist projecting from the building to support an outside scaffold.

Overhand Work. An entire wall built from a scaffold on one side of the wall only. The outside or face brickwork is laid by reaching over the wall.

Parapet. A low or dwarf wall along the edge of a flat roof, walk, terrace, etc., for ornament or protection.

Pargeting. Smearing or rough plastering a surface with mortar.

Pick and Dip Method. The routine in which the bricklayer picks up a brick with one hand and, with a trowel in the other hand dips just enough mortar to lay the brick.

Plumb Rule. A board with parallel edges and a hole near one end, in which a weight or bob may be swung.

Pointing. Inserting mortar into joints of masonry to improve its appearance.

Putlog. A piece of timber used as a cross support of a scaffold.

Quoins. Projecting courses or blocks of masonry at the corners of buildings for ornamental purposes.

Racking. Building the end of a wall in a series of steps, so that new work can be bonded with the old construction easily. Considered better practice than toothing a wall.

Rake. A slope or rack in construction.

Recess. A shallow space in a wall, such as a niche.

Reveal. The vertical side or face of an opening, usually measured from the face of the wall to the frame or trim in the space.

Rolok Wall (sometimes called Ideal or Economy Wall). A substitute for solid brick walls justified by economic considerations. Essentially a combination of several shells of brickwork, laid flat or on edge to produce a cellular type of construction in brick.

Rowlock. A row or course of brick headers laid on edge.

Run. A temporary plank scaffold over which materials can be wheeled.

Salamander. A heater having no chimney.

Salmon Brick. The soft brick of the kiln suitable for places protected from weather or heavy loads.

Scaffold Height. The height of the wall which requires another raising of the scaffold to continue the work.

Selects. The bricks accepted as suitable after culling.

Set. Another name for a brick cutting chisel. Also called a *bolster.*

Shove Joint. A vertical joint filled completely by pushing the brick through a trowel of mortar, thus filling up all the spaces.

Smoke Chamber. The space in the chimney immediately above the throat or damper, in which the wind shelf starts the smoke up the chimney.

Snap Header. A false header, consisting of a half brick, with the good end showing snap headers are prohibited in the best work.

Soffit. The lower edge or face of an arch; also called the *intrados.*

Soldier Course. A course of stretchers set on end with the faces showing on the wall surface.

Spandrel. The panel or space directly above or below a window.

Splay. A slope or bevel, particularly at the sides of a window or door.

Story High. The correct height between floors or floor joists.

Story Pole. A pole or rod on which the correct heights of floors, window sills, brick courses, etc., are indicated.

Stretcher. A brick laid on its flat side, so that the face is on the surface of the wall, and the length of the brick runs with the length of the wall.

Temper. To mix, usually by adding water, so that the mortar is in the proper condition for use.

Template. Any form or pattern, such as centering, over which masonry work may be formed and built.

Throat. The opening at the top and front of a fireplace through which the smoke passes into the smoke chamber. The damper should always be placed in the throat.

Toothing. A method of building the end of a wall so that another wall can be added without showing a definite break. Every last stretcher is left projecting half its length like a vertical line of brick teeth.

Trig. A line stretched between leads sags in the middle. To keep the line level and plumb, a brick is laid at the mid-point and the line held to its correct height by a loop of cord laid on top of the trigging brick.

Trimmer Arch. The rough shelf or arch projecting out from the chimney base into the room. The finished hearth is supported on this projection. The joists are framed around and clear of it.

Tuck Pointing. The filling in of joints in old masonry with fresh mortar to improve appearance.

Vitrified. Hard burned by great heat.

Voussoir. The angled shapes of masonry that form a complete arch when built together.

Wall Ties. Straps or strips of metal or wire that are used to reinforce or tie together two parts of a wall.

Water Table. The slight projection of the lower courses of masonry at the base of a building. It was originally intended to keep rain from running down the walls against the foundation.

Webb. The thin wall that separates the cells in hollow tile, etc.

Wind Shelf. The ledge back of the damper at the bottom of the smoke chamber. This shelf helps start smoke up the chimney.

Withe. The masonry partition between flues in the same chimney.

Chapter 7

CONCRETE BLOCKS

Concrete Blocks . . . Concrete Block Construction . . . Building the Wall

Concrete Blocks. Portland cement concrete blocks (Fig. 5.115) are a comparatively cheap and easily handled building material. Because of the ease with which they may be manufactured, the blocks are available everywhere. Practically every building code in the country permits the use of Portland cement blocks, although some codes restrict their use to small

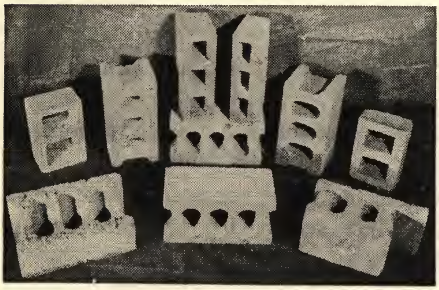


Fig. 5.115. Concrete blocks of various shapes.

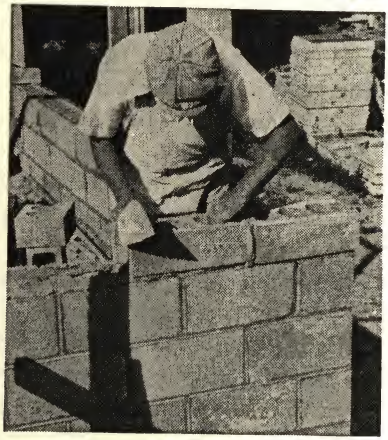


Fig. 5.116. Laying concrete blocks.

buildings. A standard block is usually 8″ wide, 8″ high, and 16″ long. Half blocks, corners, and other shapes may be made to meet any need. The aggregate may be sand or steam cinders. The cinder block has several advantages such as lighter weight, porous surface for plaster, and excellent insulating qualities.

The standard concrete block produces a wall 8″ thick, in 8″ courses when laid in a single thickness. For 100 sq. ft. of wall area, one hundred and ten

8″ × 8″ × 16″ blocks are required. Concrete building tile are smaller and lighter than concrete blocks. They are usually 12″ long and 8″ wide, but their height varies. The 3½″ and 5″ heights are the most common. Two hundred and twenty 5″, or three hundred, 3½″ tiles are required for 100

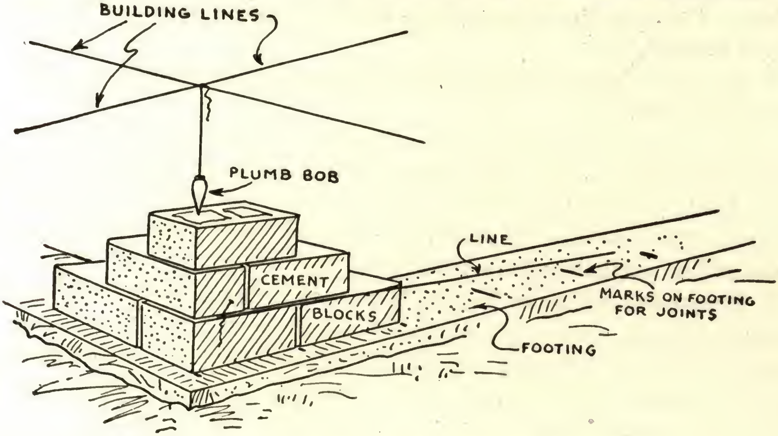


Fig. 5.117. Spotting corner with a plumb bob.

Start with one corner, and lay up a lead of about three courses of blocks, plumb, level across the top, and square with the corner. A plumb bob hung from the building lines that cross at the corner will spot the exact place where the corner should be. In Fig. 5.117 note that the bob hangs directly over the outside corner.

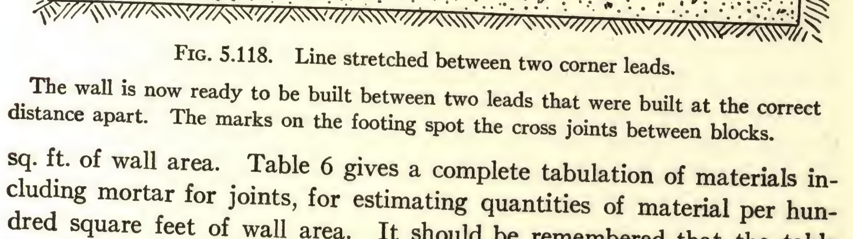


Fig. 5.118. Line stretched between two corner leads.

The wall is now ready to be built between two leads that were built at the correct distance apart. The marks on the footing spot the cross joints between blocks.

sq. ft. of wall area. Table 6 gives a complete tabulation of materials including mortar for joints, for estimating quantities of material per hundred square feet of wall area. It should be remembered that the table does not include wall openings such as doors and windows. These should be deducted before estimating the net wall area.

Concrete Block Construction. With a little practice the amateur builder can build almost any type of wall. Figure 5.116 shows how to handle the blocks when laying up a corner. Note that the workman is sighting down the corner so that the block may be set plumb and square with the work below. The following steps apply to masonry walls in general and concrete blocks in particular:

1. The footings must be in place, set up and clean ready to receive the foundation walls.

2. Fasten lines of strong cord in place on the batter boards, so that they outline the exact size and shape of the outside edges of the foundation walls to be built. Check the position of the lines to be sure that the walls will center on the footings. Measure diagonals across corners to ensure that the walls will be parallel, and the corners square.

3. Hang a few strings with light plumb bobs or small stones on them from the layout lines. These strings and bobs may be raised or lowered as the work proceeds, to help keep the work straight and plumb. A bob hung at the intersection of the strings that mark a corner may be used to start the first course corner block.

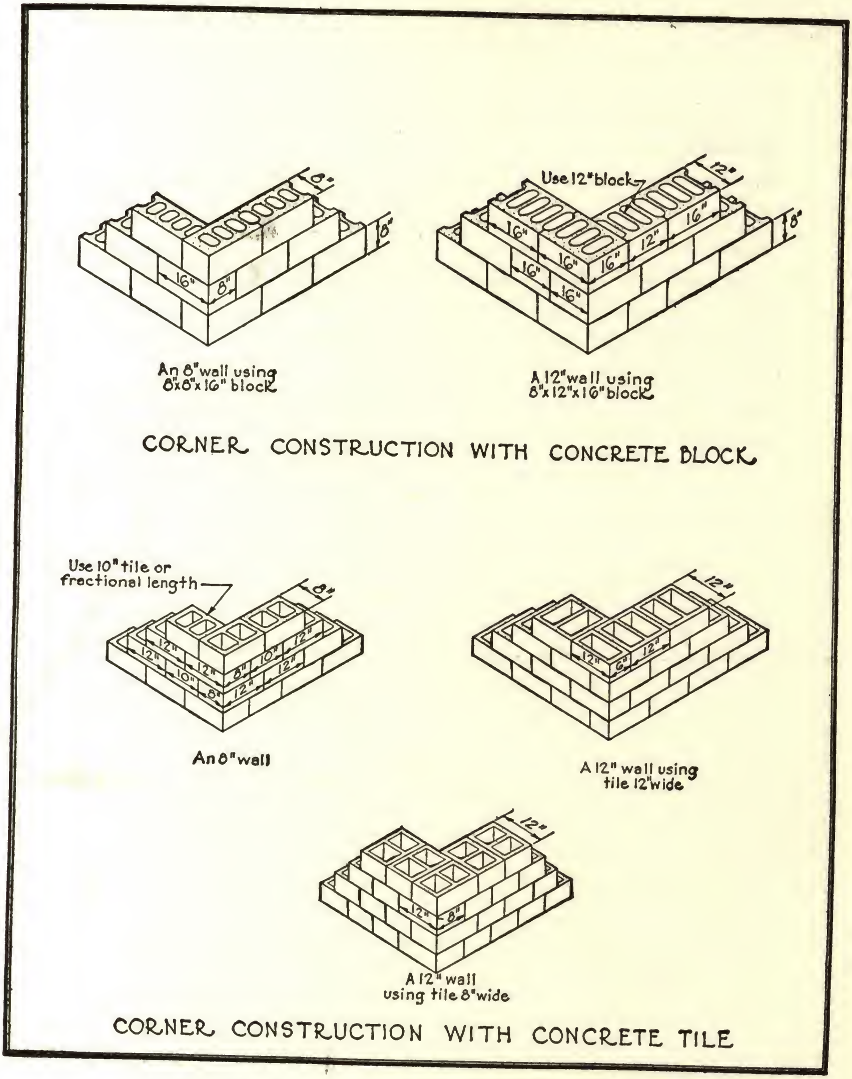
4. With footings ready and building lines placed and checked, the wall is ready to be built. First, however, it is necessary to chase out the bond to make sure that the walls may be built with the least amount of waste or cutting of blocks. Starting from one important corner, the concrete blocks are laid dry on the footing. They must be spaced about ½″ apart to allow for the cross joint between blocks. A small stick or the thickness of four blades of a folding rule is convenient for quick spacing.

5. Lay out the entire foundation with the first course of concrete blocks, as suggested above. Rarely, if ever, will the blocks and joints work out exactly right. It is necessary to shift a few blocks a little one way or another, so that the last block fits into place with enough space at each end for the joints.

6. Leave out the blocks for any openings for cellar doors, chimney foundations, etc., if they are to be near the level of the cellar floor.

7. Using a piece of chalk, mark the center of each joint on the top of the footing. These marks will help when the blocks are laid in mortar.

To assist in building important details such as the openings for doors and windows, Figs. 5.120, 5.121, and 5.122 have been included in this section. These illustrations show how wood or steel windows fit into the wall to make water-tight and neat joints around the frames. The details of Fig. 5.121, concrete lintels, merit close attention.



8"
16"
8"
An 8" wall using 8"x8"x16" block
Use 12" block
12"
16"
12"
A 12" wall using 8"x12"x16" block
CORNER CONSTRUCTION WITH CONCRETE BLOCK
Use 10" tile or fractional length
12"
10"
An 8" wall
6"
A 12" wall using tile 12" wide
A 12" wall using tile 8" wide
CORNER CONSTRUCTION WITH CONCRETE TILE

Fig. 5.119.

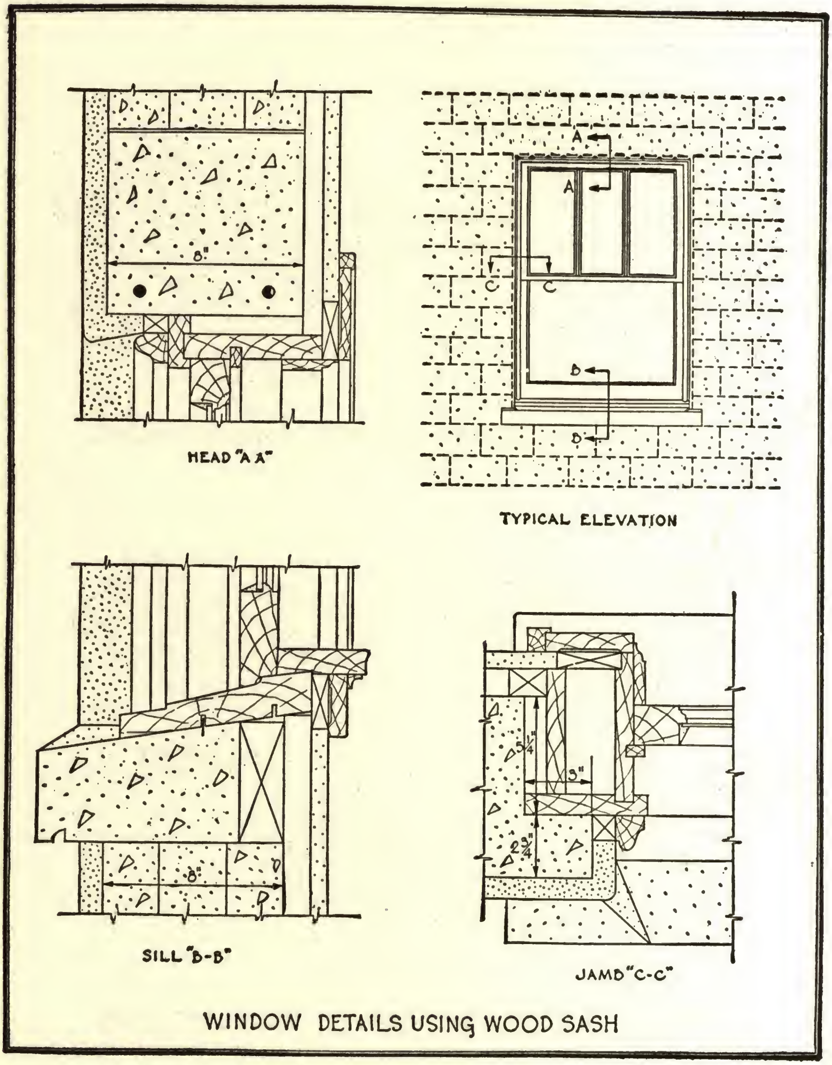

8"
HEAD "A A"
A
A
C
C
B
B
TYPICAL ELEVATION
8"
SILL "B-B"
5¼"
3"
2¾"
JAMB "C-C"
WINDOW DETAILS USING WOOD SASH

Fig. 5.120.

The concrete block chimney has been common for years. The importance of clay tile flue lining, however, must be stressed. While concrete blocks do not burn, the mortar joints disintegrate, and leave hidden and dangerous chinks through which flames may reach to start a fire.

Building the Wall. Having laid out the building lines, run out the bond, and marked all the joints or openings in the first course, the next step is the actual building of the wall.

Start with a corner located by two building lines crossing at right angles. Use a plumb bob to spot the corner on the footing. Lay the first corner block with a corner exactly under the bob. Now lay up about 3 courses of blocks, keeping the bed and cross joints about ½" thick. See Figs. 5.117 and 5.119. Follow the marks on the footing. Use a mason's level and a steel square to make the corner plumb and square, with level courses.

Always lay concrete blocks "upside down." A glance at a block will show that the edges and webs are thicker on one side than the other. The mortar joints may be laid upon the wider edges very easily, if a little care is used in placing the joint.

After one or two blocks are laid, run the tip of the trowel along the joints on both sides. This is called *striking the joint* and results in better appearance and more water-tight joints. Do not leave any holes or cracks in *any* joint. Fill up all voids completely when striking up the joints.

Lay up the other corners of the foundation using the same technique. A special effort should be made to keep all bed joints the same thickness. No two blocks should be placed so that the cross joints come one over the other. Break the joints every course.

After building two corners the wall itself may be laid between them. The chalk marks on the footing now serve to spot the joints so that the first course will fit between the corners perfectly. The following easy steps are a simple method of laying cement blocks.

1. Stretch a piece of line between the corners, as shown in Fig. 5.118. The line should lie along the top edge of the course of blocks. Use *cut* nails for line pins to hold the line as they will not turn in the soft mortar joints. The line should be stretched as *tight* as possible.

2. Spread the bed joint for *one* block at a time until the knack of laying the blocks has been acquired. Cover the webs as well as the edges of the block.

3. Pick up a block, set it on end and slap a joint (a trowelful of mortar) on the upper end. Spread the mortar evenly over the whole end with the point of the trowel.

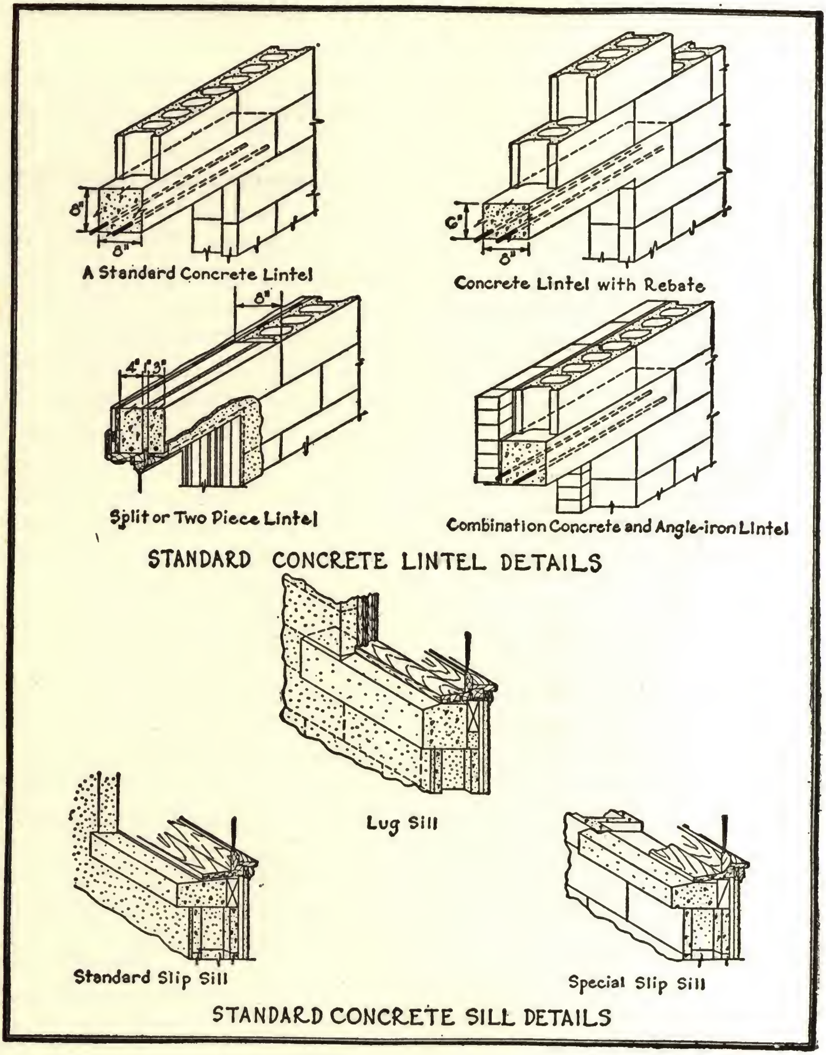

8"
8"
A Standard Concrete Lintel
C"
8"
Concrete Lintel with Rebate
8"
4"
3"
Split or Two Piece Lintel
Combination Concrete and Angle-iron Lintel
STANDARD CONCRETE LINTEL DETAILS
Lug Sill
Standard Slip Sill
Special Slip Sill
STANDARD CONCRETE SILL DETAILS

FIG. 5.121.

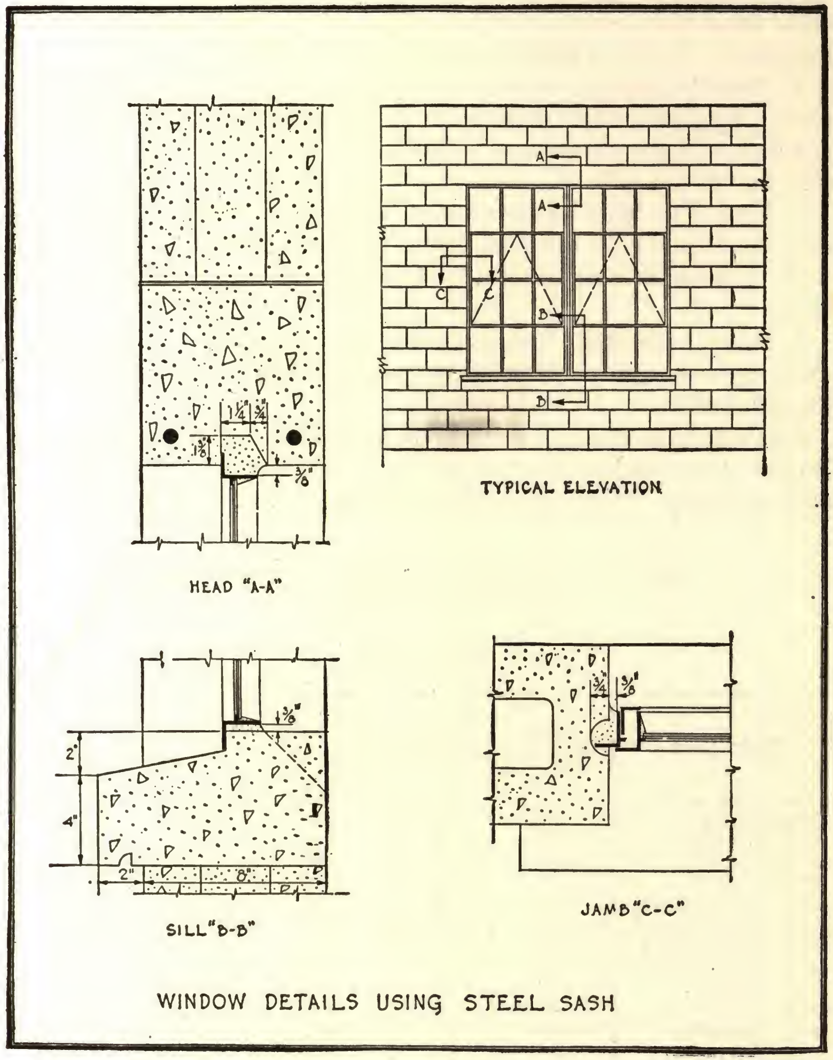

HEAD "A-A"
TYPICAL ELEVATION
SILL "B-B"
JAMB "C-C"
WINDOW DETAILS USING STEEL SASH

Fig. 5.122.

4. Pick up the block so that the *wider* edges will come on top and give it a smart bump on the ground. This will *set* the joint so that it will not slide off as the block is being placed in position on the wall. This little trick is important. It will be found to save time and temper.

5. Place the block in position on the wall using both hands to guide it into place. The block should come out to the line (about 1/16″ clear throughout), and flush with the course below. Press firmly into the bed and shove cross joint into place firmly.

6. Use a 3 lb. lump hammer to tap the block into place. The finished operation should leave the block plumb, level, and square with the line and wall. The line should come just level with the upper and outer edge of the block.

7. Strike the cross and bed joints on both sides with the tip of the trowel, clean any excess mortar from the bed course of blocks, and prepare to lay the next block.

8. It may be necessary to point up the joints if some of the mortar fell out. Do this at once as it is easier at this time. *Be sure that all cross joints are filled completely. This is the best insurance against leaking walls.*

TABLE 6. DATA ON VARIOUS CONCRETE MASONRY WALLS PER 100 SQ. FT. OF WALL AREA

Concrete Block

Description		Wall Thickness	Weight per Unit (lb.)	Number of Units (per 100 sq. ft. of wall area)	Mortar* (cu. ft.)	Weight, lb. (per 100 sq. ft. of wall area)
8″× 8″×16″	Hollow Partition Block	8″	50	110	3.25	5850
8″× 8″×12″		8″	38	146	3.50	6000
8″×12″×16″		12″	85	110	3.25	9700
8″× 3″×16″		3″	20	110	2.75	2600
9″× 3″×18″		3″	26	87	2.50	2500
12″× 3″×12″		3″	23	100	2.50	2550
8″× 3″×12″		3″	15	146	3.50	2550
8″× 4″×16″		4″	28	110	3.25	3450
9″× 4″×18″		4″	35	87	3.25	3350
12″× 4″×12″		4″	31	100	3.25	3450
8″× 4″×12″		4″	21	146	4.00	3500
8″× 6″×16″		6″	42	110	3.25	5000

* These figures are based on 3/8-inch mortar joints, 25% wastage included. Weight of mortar assumed at 103 pounds per cubic foot. For 1/2-inch mortar joints, use one-fourth more mortar than specified in the table.

TABLE 6. (*Continued*)

Concrete Tile

Description	Wall Thickness	Weight per Unit (lb.)	Number of Units (per 100 sq. ft. of wall area)	Mortar* (cu. ft.)	Weight, lb. (per 100 sq. ft. of wall area)
5"×8"×12"	8"	19.9	220	5.00	4900
5"×4"×12"	4"	9.9	220	5.00	2700
5"×6"×12"	6"	14.9	220	4.00	3800
3½"×8"×12"	8"	16.5	300	6.00	5550
3½"×4"×12"	4"	8.5	300	5.00	3050
3½"×6"×12"	6"	12.5	300	5.50	4300

Light Weight Concrete Block

8"× 8"×16"	8"	27–32	110	3.25	3300–3850
8"× 8"×12"	8"	21–24	146	3.50	3400–3850
8"×12"×16"	12"	46–54	110	3.25	5400–6300
8"× 3"×16"	3"	11–13	110	2.75	1500–1700
9"× 3"×18"	3"	14–17	87	2.50	1450–1700
12"× 3"×12"	3"	12–15	100	2.50	1450–1750
8"× 3"×12"	3"	8–10	146	3.50	1500–1800
8"× 4"×16"	4"	15–18	110	3.25	2000–2350
9"× 4"×18"	4"	19–22	87	3.25	2000–2250
12"× 4"×12"	4"	17–20	100	3.25	2050–2350
8"× 4"×12"	4"	11–13	146	4.00	2000–2300
8"× 6"×16"	6"	23–27	110	3.25	2900–3300

Light Weight Concrete Tile

5"×8"×12"	8"	10.8–12.7	220	5.00	2900–3300
5"×4"×12"	4"	5.4– 6.3	220	5.00	1700–1950
5"×6"×12"	6"	8.1– 9.5	220	4.00	2200–2500
3½"×8"×12"	8"	8.9–10.6	300	6.00	3300–3800
3½"×4"×12"	4"	4.6– 5.4	300	5.50	2000–2200
3½"×6"×12"	6"	6.8– 8.0	300	5.50	2600–3000

Concrete Brick

2¼"×3¾"×8"	8"	5	1300	18.10	8350

* These figures are based on ⅜-inch mortar joints, 25% wastage included. Weight of mortar assumed at 103 pounds per cubic foot. For ½-inch mortar joints, use one-fourth more mortar than specified in the table

Chapter 8

GLASS BLOCKS

Kinds and Sizes . . . Construction with Glass Blocks: Mortar, Full Mortar Joints, Set-in-Wood Construction

Kinds and Sizes. Considerable progress has been made during the past few years, both in the design of glass blocks, and in the methods by which they are assembled. These advances and improvements have extended considerably the usefulness of this type of construction. By referring to Fig. 5.123, which shows a glass block in section, it will be seen that its essential elements are: hollow, hermetically sealed, and partially evacuated construction, which has corrugated bearing edges to facilitate bonding between blocks. The blocks are usually made of water-clear, translucent glass, with a special rim, in the case of prismatic blocks, to prevent edge glare, and designed to be joined to adjacent blocks by mortar or wooden framing.

Glass blocks are made in a considerable variety of styles and sizes. Figure 5.124 shows a typical glass block which is designed to transmit and diffuse light uniformly. It is translucent, but not transparent. Transparent glass blocks may also be obtained, although for most purposes, the translucent block is to be preferred. It will be observed that Fig. 5.124 shows clearly the corrugated bearing edges which are provided on all four sides of the block, and are required in the methods of construction to be described later in this section. Figure 5.125 shows another style of glass block, the prismatic light directional type, which is designed to reduce glare above eye level and to improve efficiency by directing the light upward against the ceiling. Another type of prismatic block is designed to eliminate glare at or below eye level.

In addition to various styles of glass blocks, there are, of course, a number of sizes, as represented in Fig. 5.126, which portrays some of the blocks supplied by the Owens Illinois Glass Co. By referring to that figure it will be noted that there are 3 standard sizes with dimensions as given. This figure also shows one special size of block, which measures 8½″ on one face, and 7¾″ on the other. This type of block is used in constructing curved walls, and by combining these blocks in various groupings with the standard

1. Hermetically sealed unit.
2. Corrugated bearing edges.
3. Rim to prevent edge glare.
4. Mortar bond coating.
5. Exterior face of block.

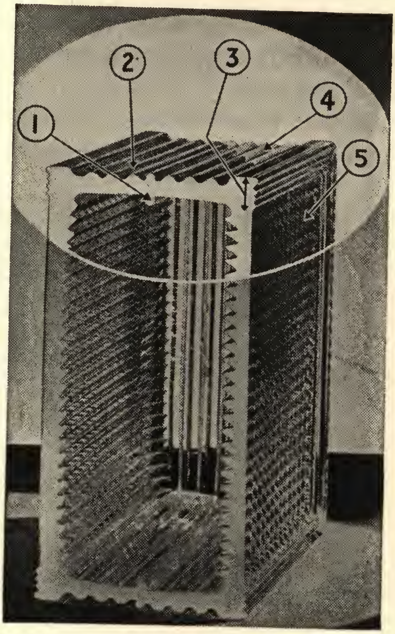


FIG. 5.123. Vertical section — Prismatic light directional glass block. *Courtesy of Owens-Illinois Glass Co.*

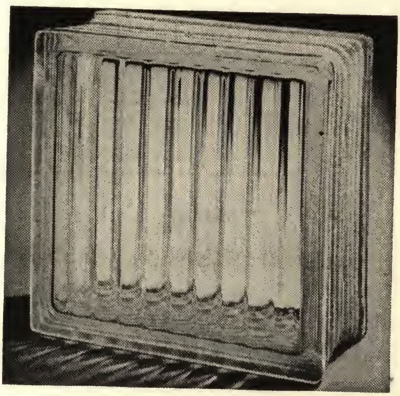


FIG. 5.124. Typical general purpose glass block. *Courtesy of Owens-Illinois Glass Co.*

blocks, which are the same length on both faces, walls may be constructed of almost any degree of curvature desired. Tables are furnished by the manufacturer showing how to group the blocks to obtain curvature of various radii in the finished walls.

Constructing with Glass Blocks. Before proceeding to describe methods of construction with glass blocks, the various advantages and disadvantages

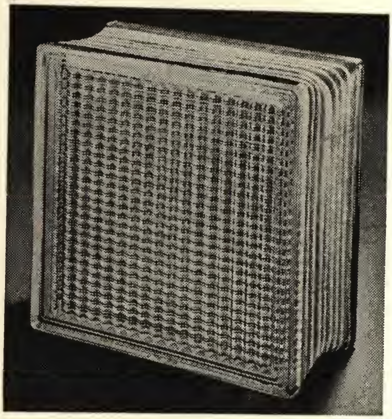
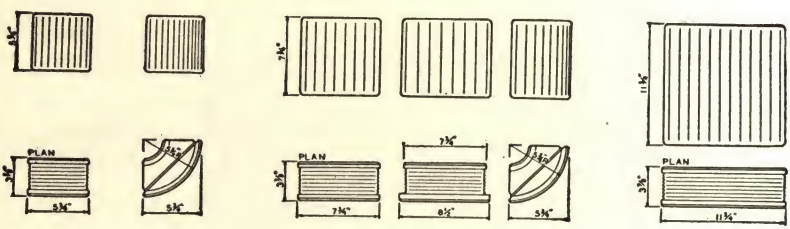


Fig. 5.125. Prismatic light — directional glass block. *Courtesy of Owens-Illinois Glass Co.*



5¾″ square block 7¾″ square block 11¾″ square block

Fig. 5.126. Various styles and sizes of glass blocks. *Courtesy of Owens-Illinois Glass Co.*

of this material should be recognized. Glass blocks must never be used to support structural loads. They are designed, when assembled as described below, to carry their own weight with an ample margin of safety, but they cannot be used to transmit stresses from other portions of the building, or from building walls above and around the area that is to be constructed of

glass blocks. The statement that "glass block construction should be regarded as a curtain wall" may not be entirely fair to this material, but it certainly furnishes a safe and sure guide to the home mechanic who wishes to introduce into his home the light which this material makes possible, while at the same time retaining the insulating value of the outer walls of the house. For these blocks, as stated above, are partially evacuated, and therefore have an excellent insulating value to help keep the house cool in summer and warm in winter. These blocks also reduce the volume of noise passing through the wall.

There are two common methods of construction with glass blocks: the mortar method, and the set in wood method. Only the mortar method may be used in outside walls, because it alone is weathertight. The use of wood framing to support the glass blocks, however, has important advantages for inside walls, or other inside construction. One of the most evident of these advantages is that walls so constructed may be taken down without damaging the glass blocks, which can then be used elsewhere.

Mortar. The first step in constructing walls of glass blocks with mortar joints is to obtain from the manufacturer a catalogue giving dimension tables. These tables make it easy to determine the number of blocks required for openings of various sizes. From them the glass block installation can readily be planned. The next step is to cut or prepare a chase around the opening in the wall in which the glass blocks are to be installed. Then the bed joint for the first course of glass blocks is prepared by spreading a layer of asphalt emulsion on the sill of this chase (Fig. 5.127). The following step is to apply expansion strips ($\frac{1}{2}'' \times 4\frac{1}{8}'' \times 25''$) continuously to the chase at the sides and top (jambs and head).

Now the first course of glass blocks can be laid. They rest on the first bed of mortar above the asphalt emulsion on the sill, and are given the necessary play for expansion by means of the strips which were installed at the sides of the wall. The joints between the glass blocks are filled with a mortar which consists of 1 part of cement, 1 part of hydrated lime, and 4 parts of pure, well graded sand (100% through a No. 16 sieve). In mixing this mortar, the water should be added a little at a time, until a fairly stiff, but working consistency has been obtained. The method of applying the mortar with a trowel, and laying the blocks, is shown in Fig. 5.128, and follows the principles which have already been described in great detail for bricks. It is, of course, important to avoid getting mortar on the face of the glass block, which would mar the appearance of the work.

Full Mortar Joints. Figure 5.129 shows the preparation of a bed joint of

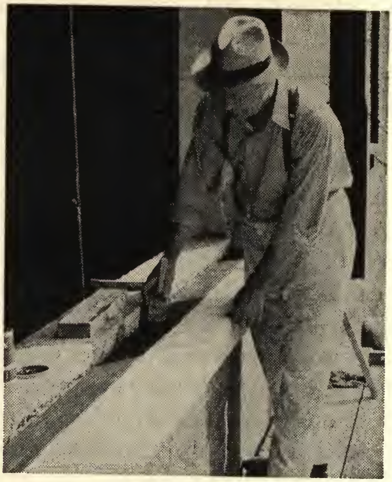


FIG. 5.127. Glass block mortar construction. Spreading asphalt emulsion on sill.
Courtesy of Owens-Illinois Glass Co.

FIG. 5.128. Glass block mortar construction. Laying first course of glass blocks.
Courtesy of Owens-Illinois Glass Co.

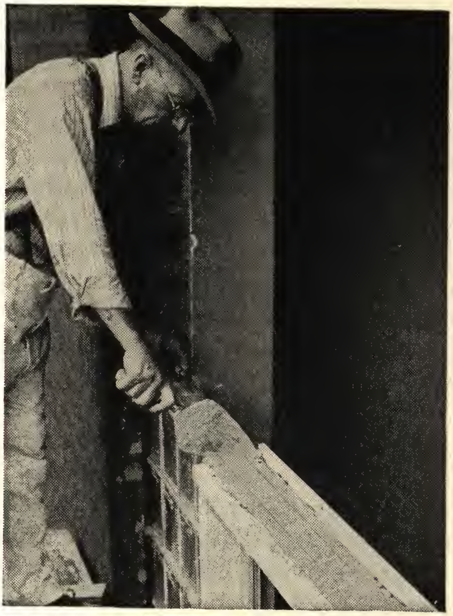


FIG. 5.129. Glass block mortar construction. Placing continuous wire reinforcing in center of mortar joint. *Courtesy of Owens-Illinois Glass Co.*

FIG. 5.130. Glass blocks set in wood. Nailing plain wedges to jamb. *Courtesy of Owens-Illinois Glass Co.*

mortar for a course of glass blocks. After the first course is laid on an asphalt emulsion bed joint, every new course is placed upon a bed joint of mortar as shown in this illustration. In addition, however, Fig. 5.129 shows the placing of continuous wire reinforcing in the center of the mortar joint. This reinforcing is necessary to provide the proper strength for walls constructed of glass blocks. It should be installed in every fourth course of the smallest blocks (which measure $5\frac{3}{4}'' \times 5\frac{3}{4}''$ on their faces), in every third course of $7\frac{3}{4}'' \times 7\frac{3}{4}''$ blocks, and in every course of the largest blocks (which measure $11\frac{3}{4}'' \times 11\frac{3}{4}''$ on their faces). This continuous wire reinforcing, as well as the expansion strips, the asphalt emulsion, and all other special materials that are described in this section, may conveniently be obtained from the manufacturer or distributor of the glass blocks.

The final operation in the construction of exterior walls of glass blocks, or in fact, any walls of glass blocks in which mortar is used, is the finishing of the joint at the sides (jambs) of the wall. This finishing operation is performed in two steps. The first step is to ram oakum between the side of the blocks at the ends of the rows, and the inner face of the chase. Then mastic caulking compound is applied over the oakum. This step completes the construction of the wall of glass blocks.

Set-in-Wood Construction. The other method of installing glass blocks consists of constructing a wooden framework around and between the glass blocks. As stated elsewhere in this section, this construction is not weathertight, and is used only for interior walls. The first step after the frame has been erected is to nail wedges without grooves to $2'' \times 4''$ members with two 2 penny nails. Space wedges at the center of each row of blocks at both jambs and head, with the thin part of wedges up. The wedges should be located 8″ on centers for 8″ blocks, and 12″ on centers for 12″ blocks. Wedges should be nailed flush with edges of the $2'' \times 4''$ frame. This operation is shown in Fig. 5.130. The wedges described in this paragraph, and the horizontal stripping, vertical strips, and grooved wedges required in the following operations, may all be obtained from the manufacturer or distributor of the glass blocks.

The second step in the installation of glass blocks in wood is to provide a row of horizontal stripping on the base from which the glass wall is to be constructed. This is done by planing off the beads of one side of the horizontal stripping, and then nailing the stripping to the wood base, so that the planed surface is down and the beaded side is up. Then the first course of glass blocks is laid so that the corrugated bearing edges on the blocks engage the beads on the stripping. Between each two blocks vertical wood

FIG. 5.131. Glass blocks set in wood. Placing vertical wood strip between blocks. *Courtesy of Owens-Illinois Glass Co.*

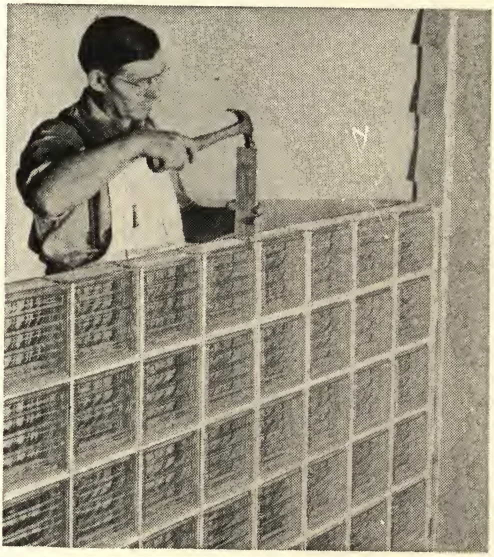


FIG. 5.132. Glass blocks set in wood. Tapping vertical strip into place. *Courtesy of Owens-Illinois Glass Co.*

strips are placed as shown in Fig. 5.131, and they are tapped down tight as shown in Fig. 5.132. A continuous horizontal wood strip is laid over each course of glass blocks. The final operation in completing a course is shown

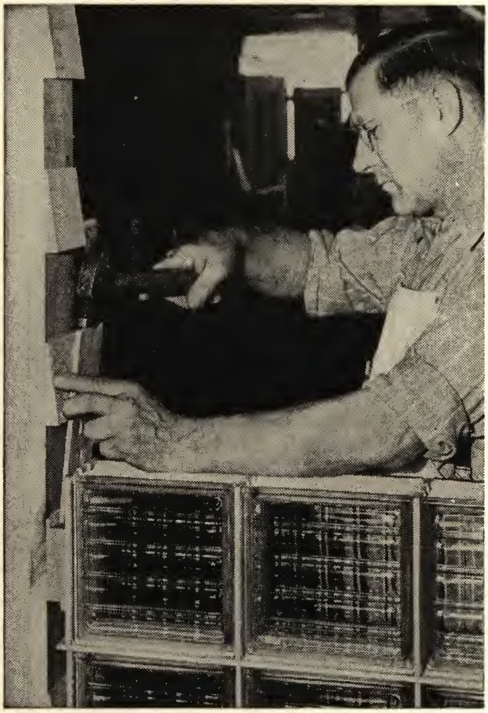


Fig. 5.133. Glass blocks set in wood. Driving in the grooved wedge to complete construction of the course. *Courtesy of Owens-Illinois Glass Co.*

in Fig. 5.133, and consists of driving in a grooved wedge to hold the course in place. After the wall of glass blocks has been completed, the wedges at the sides are concealed by any desired type of ornamental trim, which is nailed, of course, to the wood framing around the glass blocks.

INDEX

INDEX